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V/STOL AIRCRAFT AERODYNAMIC PREDICTION
METHODS INVESTIGATION. VOLUME IV. LITERA-
TURE SURVEY

Peter T. Wooler, et al

Northrop Corporation

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V/STOL AIRCRAFT AERODYNAMIC PREDICTION METHODS INVESTIGATION

Volume IV. Literature Survey

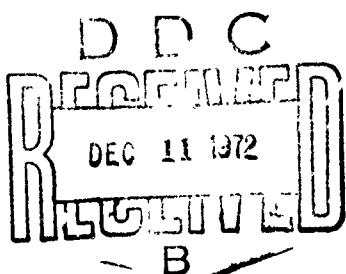
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H.C. Kao
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H. Ziegler

Northrop Corporation
Aircraft Division

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January 1972

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Analytical engineering methods are developed for use in predicting the static and dynamic stability and control derivatives and force and moment coefficients of lift-jet, lift-fan, and vectored thrust V/STOL aircraft in the hover and transition flight regimes. The methods take into account the strong power effects, large variations in angle of attack and sideslip, and changes in aircraft geometry that are associated with high disk loaded V/STOL aircraft operating in the aforementioned flight regimes. The aircraft configurations studied have a conventional wing, fuselage and empennage. The prediction methods are suitable for use by design personnel during the preliminary design and evaluation of V/STOL aircraft of the type previously mentioned.	
This report consists of four volumes. The results of a literature survey are presented in this volume. The theoretical development of the prediction methods may be found in Volume I. The methods are applied to a number of V/STOL configurations in Volume II. Details of the computer programs associated with the prediction methods are given in Volume III.	

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XV-5A						
V/STOL Stability and Control						
Aerodynamic Characteristics (Subsonic)						
Forces (Normal Force, Lift, Side Force)						
Moments (Pitching, Rolling, Yawing)						
Rotary Derivatives						
V/STOL Aerodynamics						
Nonlinear Aerodynamics						
Wing Stall						
Separated Flows						
V/STOL Transitional Flight						
Engine Wake Effects						
Jet Exhaust Fields						
Jet Interference Effects						
Jet in Cross Flow						
Jet Path						
Multiple Jets						
Jet Interaction						
Power Effects						
Engine Inlet Effects						
Vortices						
Computer Programs						

V/STOL AIRCRAFT AERODYNAMIC
PREDICTION METHODS INVESTIGATION

Volume IV
Literature Survey

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FOREWORD

This report summarizes the work accomplished by the Aircraft Division of Northrop Corporation, Hawthorne, California, for the Air Force Flight Dynamics Laboratory, AFSC, Wright Patterson Air Force Base, Ohio, under USAF Contract No. 13615-69-C-1602 (Project 698 BT). This document constitutes the Final Report under the contract.

This work was accomplished during the period 1 May 1969 to 31 January 1972, and this report was released by the authors in January 1972. The Air Force Project Engineers were Mr. Robert Nicholson and Mr. Henry V. Woolard of the Control Criteria Branch, Flight Control Division, AFSDL. Their assistance in monitoring the work and providing data is greatly appreciated.

This technical report has been reviewed and is approved.

C.B. Westbrook
C. B. Westbrook
Chief, Control Criteria Branch
Flight Control Division
Air Force Flight Dynamics Laboratory

ABSTRACT

Analytical engineering methods are developed for use in predicting the static and dynamic stability and control derivatives and force and moment coefficients of lift-jet, lift-fan, and vectored thrust V/STOL aircraft in the hover and transition flight regimes. The methods take into account the strong power effects, large variations in angle of attack and sideslip, and changes in aircraft geometry that are associated with high disk loaded V/STOL aircraft operating in the aforementioned flight regimes. The aircraft configurations studied have a conventional wing, fuselage and empennage. The prediction methods are suitable for use by design personnel during the preliminary design and evaluation of V/STOL aircraft of the type previously mentioned.

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SECTION I

INTRODUCTION

This volume is the fourth and final volume treating V/STOL aerodynamic prediction methods. The results of an extensive literature survey are presented in this volume. The objective of the literature survey was to investigate the available data relevant to the three V/STOL aircraft concepts being studied under this program and to identify areas for which further wind tunnel test data were required. This information would then be used to define a wind tunnel test program which would generate the required data. The data obtained from this test program, together with data already available, would be used to validate and/or modify the prediction methods developed during the investigation.

The majority of the reports were collected following literature searches carried out by the Defense Documentation Center and the NASA Scientific and Technical Information Facility. Those searches of the literature were made in May and June of 1969. Although reports pertaining to wind tunnel test data were of prime interest, searches were also made to identify relevant flight test data and theoretical aerodynamic prediction methods. Additional reports were made available by Air Force Flight Dynamics Laboratory and NASA Langley Research Center personnel. Some reports were also available from previous literature reviews by Northrop personnel.

With the application of the literature survey to the aerodynamic prediction methods in mind, the survey was broken down into two general areas:

1. Literature relevant to aircraft components.
2. Literature relevant to aircraft concepts.

The literature dealing with aircraft components is discussed in Section II of this volume. The literature survey has been organized to parallel the methods development presented in Volume I. Thus, subsections on the literature treating wing, body, engine inlet and jet exhaust may be found in Section II.

The V/STOL concepts studied in this investigation have been the lift-fan, lift-jet and vectored thrust concepts. Consequently, Section III includes a discussion of the literature pertaining to each of these concepts.

A summary table, indicating the primary areas of investigation or analysis, of the more applicable of the references is given in an Appendix.

The literature survey was completed in October 1969 and was first published in the Interim Report, Northrop Report NOR 70-121, in June 1970. Since that time, further publications, relating to this investigation, have appeared in the literature. No attempt has been made to incorporate these additional reports into the summary tables. However, they have been included in the list of references as References 278 through 315.

SECTION II

LITERATURE ON AIRCRAFT COMPONENTS

1. WING EFFECTS

The references dealing with the aerodynamic characteristics of the wing can be separated into those treating the power effects and those dealing with nonlinear wing aerodynamics. The references dealing with the power effects are discussed in Sections II, 3 and II, 4.

a. Nonlinear Aerodynamics

Reference 55. - A nonlinear theory of small aspect ratio rectangular wings is presented. In this theory, the wing is divided, along the span, into a number of equal panels. The vorticity for each panel is concentrated on a line at the quarter chord of the panel. The vorticity is assumed to be constant along the wing span. The tip vortices are assumed to be rectilinear and directed along the local flow velocity vector at the trailing edge of the wing. The intensities of the vortices are determined from the boundary conditions (no leakage condition) on the three-quarter chord lines of each panel. Calculations of the aerodynamic characteristics of the proposed method agree quite well with test data for a wing having an aspect ratio of unity. For a wing with an aspect ratio of five, the stall behavior of the wing is not correctly calculated by this approach.

Reference 72. - Semispan-wing models were tested at angles of attack from 0° to 180° at low subsonic speeds. Eight plan forms were considered, both swept and unswept with aspect ratios ranging from 2 to 6. Except for a delta-wing model of aspect ratio 2, all models had a taper ratio of 0.5 and an NACA 64A010 airfoil section. The delta-wing model had an NACA 0005 (modified) airfoil section. With two exceptions, the models were tested both with and without a full-span trailing-edge flap deflected 25° . The Reynolds numbers based on the mean aerodynamic chord were between 1.5 and 2.2 million. Lift, drag, and pitching-moment coefficients are presented as functions of angle of attack.

Reference 113. - Presented in this report is a comprehensive review of the existing technical literature and a design summary of stall characteristics applicable to light straight wing aircraft. These characteristics are obtained with the aid of a digital computer program which utilizes methods employing lifting line theory and the available experimental test data for wing section characteristics. The computer results are presented in the form of stall charts suitable for preliminary design purposes.

Reference 201. - Information from the literature and from recent investigations is used to summarize briefly the effects of airfoil section parameters and flow variables on the aerodynamic characteristics of two-dimensional symmetrical airfoils at high angles of attack. The results presented indicate that airfoil thickness ratio, Reynolds number, Mach number, and surface roughness can all have an important effect on the maximum lift coefficient. The effect of surface roughness seems to be particularly important. Not only can surface roughness cause large decreases in maximum lift coefficient, but also the magnitudes of the effects of Reynolds number, Mach number, and airfoil thickness ratio are much reduced by surface roughness. Beyond the stall, changes in section thickness ratio appear to have little effect on the aerodynamic characteristics of airfoil sections. An investigation of one section through an angle of attack range of from 0° to 360° shows that the drag coefficient reaches a value of 2 at an angle of attack of 90° .

Reference 202. - The results of an investigation of the two-dimensional aerodynamic characteristics of 15 NACA airfoils at four Reynolds numbers from 2.0×10^6 to 0.7×10^6 are reported in this reference. These data, together with those from previous NACA papers for the same airfoils at three Reynolds numbers from 3.0×10^6 to 9.0×10^6 , are presented and analyzed in the present paper. The airfoils investigated consisted of 10 systematically varied NACA 6-series airfoils and 5 airfoils of the NACA 4- and 5-digit series. The NACA 6-series airfoils had thickness ratios varying from 9 to 18 percent of the chord, design lift coefficients varying from 0 to 0.6, and positions of minimum pressure on the basic thickness form at zero lift varying from 30 to 60 percent of the chord. The NACA 4- and 5-digit-series sections investigated consisted of the NACA 0012, and the NACA 44- and 230-series sections of 12 percent and 15 percent thickness. The tests were made for both smooth and rough surface conditions and also included the determination of

the effectiveness of the different airfoils at various Reynolds numbers when equipped with split flaps.

The results of the investigation indicate that the drag coefficient at the design lift coefficient and the maximum lift coefficient are the important aerodynamic characteristics which are most affected by variations in the Reynolds number between 9.0×10^6 and 0.7×10^6 . For each of the 15 airfoils in both the smooth and rough surface conditions, the drag coefficient at design lift increased as the Reynolds number was lowered from 9.0×10^6 to 0.7×10^6 . For the smooth NACA 6-series airfoils the magnitude of this increase became larger with increasing airfoil thickness and with rearward movement of the position of minimum pressure on the basic thickness form at zero lift. In the rough surface condition and at the lower Reynolds numbers in the smooth surface condition, the saving in minimum drag to be derived from the use of NACA 6-series as compared with NACA 5-digit series airfoil sections disappears. Decreasing the Reynolds number from 9.0×10^6 to 0.7×10^6 caused reductions in the maximum lift of all the airfoils in both the smooth and rough surface conditions. The magnitude and character of this reduction varied rather inconsistently with airfoil design and surface condition, however, so that the comparative merits of a group of airfoils changed markedly and in a rather unpredictable manner with Reynolds number and surface condition.

Reference 236. - Two analytical methods are presented for determining the spanwise lift distribution. One method is a lifting surface theory and the other a lifting line method. Calculations using the two methods are compared and show that the lifting line method, which takes much less computational time, agrees extremely well with the lifting surface theory.

Reference 237. - A method is presented which allows the use of nonlinear section lift data in the calculation of the spanwise lift distribution of unswept wings with flaps or ailerons. The method is based on lifting-line theory and is an extension to the method of Reference 239. A few comparisons of calculated lift and stall characteristics with experimentally obtained data are shown.

Reference 239. - A method is presented for calculating wing characteristics by lifting-line theory using nonlinear section lift data. Detailed examples are given for symmetrical lift distributions. Calculated wing characteristics are compared with test data and agree very well for the range of angle of attack considered ($0^\circ \leq \alpha \leq 20^\circ$).

Reference 240. - The experimental and calculated aerodynamic characteristics of 22 tapered wings are compared. The wings have aspect ratios from 6 to 12 and taper ratios from 1.6 : 1 to 5 : 1. Some of the data are relevant to the nonlinear angle of attack range.

Reference 241. - The aerodynamic characteristics of the NACA 0012 airfoil section were obtained at angles of attack from 0° to 180° . The tests were conducted in a low turbulence pressure tunnel at Mach numbers no greater than 1.15.

Reference 258. - Semi-empirical methods are given for determining wing lift and pitching moment in the nonlinear angle of attack range.

2. BODY EFFECTS

The references dealing with body aerodynamics can be separated into those treating power effects and those dealing with nonlinear body aerodynamics.

a. Power Effects

Reference 75. - Data from tests of a wing-body configuration with a fan mounted in the fuselage are presented. Power-on and power-off pitching moment, normal force and axial force were obtained and comparisons made to determine scale effects and wall effects. Some pressure information on the fuselage was obtained.

Reference 76. - A configuration of a jet in a fuselage at two locations, with and without a wing attached, was tested. Pitch plane forces and moments were obtained. No inlet effects were determined.

Reference 77. - Test results for a fan-in-fuselage with power on and power off are presented. Pitch plane forces and moments are given. Comparisons with theory, which treats the configuration as a thin cylindrical ducted fan, are made. Poor correlation is obtained at high forward speeds.

Reference 163. - The results of static bench tests for jet and inlet with wing and fuselage are presented. Only thrust and temperature data are given. These tests were conducted primarily to examine ground effects.

b. Nonlinear Aerodynamics

Reference 90. - Test results for non-aerodynamic shapes, such as parallelepipeds and cylinders, are presented. This investigation has little applicability to the present study.

Reference 224. - This reference presents vorticity measurements for an ellipsoid of revolution at low angle of attack.

Reference 225. - Drag measurements for a circular cylinder started impulsively from rest are presented. This reference also presents the drag due to arbitrarily positioned vortices near a circular cylinder.

References 234 and 242 document methods for tracking vortices in the presence of a cylindrical body (Ref 242), and a body with an elliptical cross section (Ref 234). The analytical treatment of the bodies is restricted to simple shapes. The vortex tracking method of this study is essentially an attempt to extend the same concept to general body shapes.

References 243, 258 and 259 are simplified methods of producing body nonlinear aerodynamics. They utilize slender body theory results and the viscous crossflow concept for nonlinear forces and moments. These methods are limited to bodies of revolution, primarily.

3. INLET EFFECTS

Experimental data are available for three types of lift-fan configurations: fan-in-fuselage; fan-in-wing; and fan-in-semi-span wing.

References 71, 75, 166, 169 and 189 present data for fan-in-fuselage models. The reports cover one configuration which was tested with various inlets and in two model scales. The single fan is located at the intersection of the wing quarter-chord and the fuselage centerline. All tests yielded force data and fuselage pressure data. References 75, 166, 169 and 189 contain data on installed fan performance. Wing component lift is presented in References 75, 169 and 189.

References 78, 81, 151-153, 186 and 261 present results of tests involving fan-in-wing configurations. References 78 and 81 present data for a swept wing model with two to four fans located at the trailing and/or leading wing roots. The XV-5A configuration is discussed in References 151-153. Test results for a shoulder-wing, twin-fan configuration are found in Refs. 186

and 261. All tests present data on overall model forces and on installed fan performance. References 81, 151-153, 186 and 261 also give wing pressure data.

References 166 and 267 discuss tests of single fan, semi-span models. The wing of Reference 267 contains a comparatively crude fan. Basic force data are presented, as well as a limited amount of pressure data. Additional tests of complete configurations are discussed in other sections of this report.

Documented analytical methods for fan-in-wing configurations are of two types: those employing two-dimensional conformal transformation techniques; and, those involving complicated three-dimensional potential flow computer programs.

References 1, 4, 10 and 5, document potential flow analyses. All involve the use of complex variable analysis and conformal transformations. Reference 56 gives a detailed discussion of the applicability of the Kutta condition at the trailing edge of the airfoil, and demonstrates that the form of the two-dimensional solution can be made to fit three-dimensional data. The two-dimensional analysis of Reference 1 is extended to finite wings in Reference 4, by means of lifting line theory. Quantitative results are poor. It may be that this results from difficulties in representing the jet in two-dimensional potential theory, or it may be the result of the two-dimensional inlet flow which yields incorrect section lift.

References 94, 127 and 250 describe the use of computer techniques to simulate three-dimensional flow about arbitrary lift-fan configurations by means of source panels and vortex lattices. Results are in good agreement with data.

References 230 and 268 present inlet analyses based upon simple momentum theory. Reasonably accurate results are obtained.

References 7 and 57 apply two-dimensional and three-dimensional flow analysis to inlet distortion studies. These are of limited value to the present investigation.

4. JET EXIT EFFECTS

For the purposes of this investigation, interest is centered on the interference effects due to a jet efflux which is directed at large angles both to a crossflow and to a supporting system, which may consist of a wing, body or flat plate.

The relationship between the crossflow and jet exit velocity defines two major areas of interest. The condition of a very small crossflow, when compared with the jet exit velocity, is termed the hover phase. The condition of comparable magnitudes of crossflow and jet exit velocities is called the transition phase.

a. Hover Phase

References 78 and 216 indicate that for an aircraft hovering out of ground effect, the jet-induced lift loss is a function of overall planform area and the rate of mixing of the exhaust gases and the surrounding air. An expression for the relationship between the decay of the jet and the induced loads is presented in References 78 and 216. Reference 216 shows that the lift loss is a linear function of the square root of the planform to jet area ratio, as well as being a function of the jet decay characteristics.

A considerable amount of experimental data is available for the case of a single jet, or a cluster of jets, emerging from the central area of a wing or body in ground effect. For a single jet, the jet efflux entrains the free air between the lower surface of the wing-body and the ground, and the resulting induced velocities tend to increase with decreasing ground clearance. Surface pressures well below ambient are thereby generated on the lower surface, producing significant reductions in the net upward thrust.

References 174, 216, 220, 221, 232 and 264 concern themselves with evaluating the loss of effective jet thrust caused by the induced pressure forces on supporting structures in ground proximity. Several simple planforms (circular, rectangular and triangular plates) as well as models of VTOL airframes are studied. Single and multiple circular and rectangular jets are considered.

Reference 220 presents a method for correlating test data for single, centrally located jets. The use of this method for correlating data from full-scale tests, using hot jets, is justified in Reference 232.

Reference 264. - The problem of scaling is investigated further for a two-jet configuration.

Further investigations relevant to the hover phase are documented in References 59, 165, 210, 217, 223 and 266. Details of those tests and others are given in summary form in Table I. Survey papers are presented in References 78, 256, 262 and 263.

b. Transition Phase

A summary of the available data is shown in Table II. The test data may be classified in two categories:

1. Data for a single jet exhausting from a flat plate simulating an infinite plane boundary.
2. Data for multiple jets in a wing body configuration.

References 252, 228, 245, 246 and 274 present jet centerline data for single jets exhausting normally from a flat plate.

References 271, 272 and 275 present data on the jet centerline for single jets exhausting at various angles to the crossflow.

References 184, 211, 246 and 274 give data for the plate pressure coefficients and References 246, 274 and 275 define certain features of the flow using visualization techniques.

The literature search identified a lack of data on plate pressure coefficients for single jets exhausting at angles other than 90° to the crossflow. No data of any kind for multiple jets exhausting from a flat plate was located.

Multiple-jet data for jets exhausting from wings, bodies, or other configurations are presented in References 5, 30, 34, 76, 193, 214, 217, 228 and 270. A summary of the test data obtained is included as part of Table II.

The analytical investigations have been directed toward obtaining the jet deflection and deformation. There have been basically three approaches to the problem of obtaining the jet centerline. They are:

1. An inviscid model in which the jet boundary is replaced by a vortex sheet which at time $t = 0$ is fixed and is then allowed to deform

freely. Time is then related to distance along the jet through the jet velocity (References 231 and 276).

2. A model which assumes that the deflection of the jet is due to a cross flow drag force (References 206, 226, 255, 265 and 272).
3. A model which assumes that the jet is deflected due to both a cross flow drag force and viscous entrainment of cross flow fluid (References 227, 228, 271 and 274).

References 56, 94, 95, 120, 127, 226, 228, 250, 251 and 255 investigate the computation of the aerodynamic characteristics of an aircraft component which contains a jet exhausting at an angle into the freestream.

References 12, 23, 38, 123, 203, 256 and 263 are review papers covering the problem area and contain test data and analytical results.

Conference proceedings relating to the subject may be found in References 78, 262 and 149.

TABLE I. SUMMARY TABLE FOR HOVER PHASE

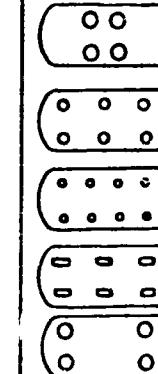
REFERENCE	YEAR	MODEL	TEST DATA	ANALYSIS	NO. OF JETS	JET ARRANGEMENT	COLD JET	HOT JET	GROUND EFFECT	AREA, PLATE	AREA, JET	FORCE DATA	PRESSURE DATA
59	1969	161 XV-48	X		6		X		X			X	
78	1966	VARIOUS				SURVEY PAPER							
163	1963	PLATE	X	1			X		X	64	X		
					1		X		X	64	X		
					2		X		X	64	X		
							X		X		X		
210	1960	PLATE	X	1			X		X	10	X		
					4		X		X	40	X		
					6		X		X	27	X		
					8		X		X	20.5	X		
		WING-BODY	X	2			X		X	10,20	X		
216	1966	WING-BODY	X	1			X		X	34.5-49.5	X	X	
					4		X		X	34.5-49.5	X	X	
					6		X		X	34.5-49.5	X	X	
					8		X		X	34.5-49.5	X	X	

TABLE I. (Continued)

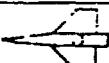
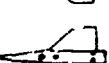
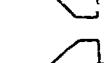
APPARATUS	YEAR	MODEL	TEST DATA	ANALYSIS	NO. OF JETS	JET ARRANGEMENT	COLD JET	HOT JET	GROUND EFFECT	AREA, PLATE	AREA, JET	FORCE DATA	PRESSURE DATA
216 cont		PLATE	X		1		X		X	10-69.5		X	X
			X		1		X		X	38-75		X	X
			X		1		X		X	36.5-49		X	X
217	1966	WING-BODY	X		1		Y		X			X	
			X		4		X		X			X	
			X		1		X		X			X	
			X		4		X		X			X	
			X		2		X		X			X	
			X		6		X		X			X	
220	1962	PLATE	X	X	1		X		X	10-100		X	
			X	X	1		X		X	10-100		X	
			X	X	1		X		X	10-100		X	
221	1958	PLATE	X		1		X		X	5.1-128		X	X
			X		1		X		X	20.4-81.5		X	X
			X		1		X		X	46-127		X	X
		WING-BODY-TAIL	X		1		Y		X			X	
		PLATE WITH CHANNELS	X		1		X		X	127		X	X

TABLE I. (Concluded)

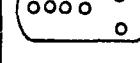
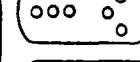
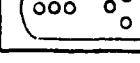
REFERENCE	YEAR	MODEL	TEST DATA	ANALYSIS	NO. OF JETS	JET ARRANGEMENT	COLD JET	HOT JET	GROUND EFFECT	AREA, PLATE	AREA, JET	FORCE DATA	PRESSURE DATA
223	1966	PLATE	X	1				X	X	19.5- 64.0	X	X	
			X	6				X		19.4- 43.6	X		
232	1967	PLATE	X	1			X		X	142		X	
			X	1				X	X	142		X	
262	1968	PLATES	X	1,4		SURVEY PAPER		X	X	X	150, 83		
		WING-BODY	X	1,4				X		X	39		
		X-14	X	2					X	X			
		WING-BODY-TAIL	X	8 10 12	6 DAC MODELS			X		X			
264	1969	BODY FUSELAGE	X	2			X	X	X			X	
264	1968	FULL SCALE VTOL FIGHTER A/C	X	6				X	X			X	
			X	6				X	X			X	
			X	6				X	X			X	

TABLE II. SUMMARY TABLE FOR TRANSITION PHASE

REFERENCE	YEAR	PLATFORM	TEST DATA	ANALYSIS	NUMBER OF JETS	GROUND PROXIMITY	FORCE DATA	PRESSURE DATA	FLOW VISUALIZATION	JET CENTERLINE
5	1964	VARIOUS	X		1-5	OUT	X	X		
13	1967	VARIOUS	X	X	1-4	IN, OUT	X	X		
23	1968	VARIOUS	X	X	1-4	IN, OUT	X	X		
30	1962	VARIOUS	X		4	OUT	X			
34	1961	WING-BODY	X		1	IN, OUT	X			
38	1965	VARIOUS	X		1-5	IN, OUT	X			
56	1961	WING	X	X	1	OUT	X			
76	1963	WING WING-BODY	X		1	OUT	X			
78	1966			CONFERENCE PROCEEDINGS						
94	1968	WING		X	1	IN, OUT				
95	1967	WING		X	1	OUT		X		
120	1968	FLAT PLATE		X	1	IN, OUT	X			
123	1966	VARIOUS	X	X	1, MULTIPLE	IN, OUT	X	X		
127	1967	WING		X	1	OUT	X	X		
148	1968	CYLINDER FLAT PLATE	X		1	IN		X	X	
149	1967			CONFERENCE PROCEEDINGS						
168	1961	WING	X		1	IN, OUT	X	X		
184	1964	WING	X		1	OUT		X	X	X
193	1961	VARIOUS	X		1-4	OUT	X			
203	1968	VARIOUS	X	X	1-2	OUT	X	X		
206	1969			X	1	OUT				X
211	1963	FLAT PLATE	X		1	OUT		X		
214	1964	WING-BODY	X		1-4	IN, OUT	X			
217	1966	WING-BODY	X		1-4	X	X			
226	1964	WING FLAT PLATE		X	1-8			X	X	X
227	1966	FLAT PLATE		X	1			X		X
228	1957	WING	X	X	1-2	OUT		X		
231	1969	FLAT PLATE		X	1	OUT				X
245	1963	FLAT PLATE	X	X	1	OUT				X
246	1965	FLAT PLATE	X		1	IN, OUT	X	X		X
250	1963	WING		X	1	OUT	X			X
251	1967	WING	X	X	1-4	OUT	X	X		X
252	1958	FLAT PLATE	X		1	OUT				X

TABLE II. (Concluded)

REFERENCE	YEAR	PLATFORM	TEST DATA	ANALYSIS	NUMBER OF JETS	GROUND PROXIMITY	FORCE DATA	PRESSURE DATA	FLOW VISUALIZATION	JET CENTERLINE
255	1961	FLAT PLATE WING	X	X	1-2	OUT	X	X		X
256	1969	SURVEY PAPER								
262	1969	CONFERENCE PROCEEDINGS								
263	1968	SURVEY PAPER								
265	1969	FLAT PLATE		X	1	OUT				X
270	1969	WING	X		2	OUT	X	X		
271	1969	FLAT PLATE	X	X	L	OUT				X
272	1969	FLAT PLATE	X	X	1	OUT				X
274	1969	FLAT PLATE	X	X		OUT	X	X		X
275	1968	FLAT PLATE	X	X	1	OUT		X		X
276	1942			X	1	OUT				X

SECTION III

LITERATURE ON AIRCRAFT CONFIGURATION CONCEPTS

This portion of the literature survey will be a discussion of the existing experimental and theoretical data pertinent to complete configurations of the three V/STOL concepts, lift-fan, lift-jet, and vectored thrust.

Included in this section are three tables which list and describe in detail the applicable experimental reports pertaining to each of the V/STOL concepts. In conjunction with these tables there are included three lists containing abstracts on each of the aforementioned experimental reports. The lists also contain abstracts on reports which are not included in the experimental tables, but nevertheless are pertinent to the investigation, such as theoretical and analytical reports.

The discussion will now be focused on each of the V/STOL concepts.

1. LIFT-FAN CONCEPT

An examination of Table III reveals that a great deal of time and effort has been expended on this V/STOL concept, especially on the XV-5A program. Wind tunnel tests have been conducted on three different lift-fan locations, in the wing, fuselage, and fuselage pods. In addition to the normal six-component force and moment data being obtained, there were tests conducted to obtain the local flow field around the lift-fan location by static pressure recordings.

There are test data covering the hover, transition, and conventional speed regimes for both wind tunnel models and full-scale flight aircraft. Data are available for hover in and out of ground effect. In addition, there are analytical reports which contain methods to predict the static and dynamic stability derivatives and also flight test data to substantiate these predictions.

Abstracts of Lift-Fan Concept Reports

5. Kuhn, R. E., McKinney, M. O., Reeder, J. P., Aerodynamics and Flying Qualities of Jet V/STOL Airplanes, SAE Paper 864A, April 1964 (A64-20157)

TABLE III. SUMMARY OF LIFT-FAN EXPERIMENTAL DATA

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A summary of information on airplane aerodynamics, ground effect, propulsion system aerodynamics, stability and control, and flying qualities of jet V/STOL airplanes (both direct jet lift and lift-fan configurations) is presented.

22. McKinney, M. O., Newsom, W. A., Fan V/STOL Aircraft, New York Academy of Sciences, Annals, Vol. 154, Nov. 1968 (A69-15565)
A summary of information on airplane aerodynamics, ground effects, propulsion system aerodynamics, stability and control of fan V/STOL aircraft (primarily ducted fan and lift-fan configurations) is presented.

36. Hall, L. P., Hickey, D. H., Kirk, J. V., Aerodynamic Characteristics of a Full-Scale Fan-in-Wing Model Including Results in Ground Effect with Nose-Fan Pitch Control, NASA TN D-2368, (64-28323)
Model had a mid-mounted wing of A. R. = 3.1. Results cover the fan-powered flight speed range from 0 to 100 knots. Longitudinal and lateral-directional characteristics with and without fan exhaust vectoring, downwash at the horizontal tail, and the effects on performance of exhaust gas reingestion are included. Installed fan performance was measured for the fan-powered flight speed range. Control power available by means of throttling lift-fan exhaust and by modulating pitch-fan thrust is presented.

41. Anon, Aerodynamics of Power Plant Installation, AGARDograph-103, 1965 (N66-22286)
A compilation of technical papers presented at the 1965 AGARD meeting on The Aerodynamics of Power Plant Installation, Part 2. Contents include discussions on air inlets and nozzles, airframe propulsion system interference, VTOL propulsion including jet lift intakes and exhausts, also lift-fan inlets and airframe VTOL propulsion interference effects.

60. Goldsmith, R., Hickey, D., Characteristics of Aircraft with Lifting-Fan Propulsion Systems for V/STOL, IAS Paper No. 63-27, Jan. 1963 (A63-11581)
Results from wind tunnel tests of several large-scale lifting-fan

models (Refs. 36, 39, 71) are analyzed with respect to the induced lift, pitching moment, and flying qualities. Rudimentary methods for estimating induced lift and the thrust-drag relationship are also presented.

71. deSavigny, R. A., Hickey, D. H., Aerodynamic Characteristics in Ground Effect of a Large-Scale Model with a High Disk-Loading Lifting Fan Mounted in the Fuselage, NASA TN D-1557, Jan. 1963 (N63-11617)

Large-scale VTOL fan-in-fuselage airplane model tested had a shoulder-mounted unswept wing of aspect ratio 5. Characteristics of the model with and without the horizontal tail were obtained with the wing at 1.83 and 2.93 fan diameters from the simulated ground plane installed above the wind tunnel floor. Test airspeeds ranged from 20 to 80 knots. Longitudinal forces and moments, some installed fan performance, static-pressure distributions on the fuselage, and downwash at the horizontal tail are presented.

78. Anon, Conference on V/STOL and STOL Aircraft, NASA SP-116, April 1966 (N66-24606)

A compilation of papers presented at the 1966 NASA Conference on V/STOL Aircraft. Contents include discussions covering the results of NASA research on problems associated with V/STOL aircraft, such as, aerodynamics and propulsion of helicopters and propeller V/STOL, also lift-fan and lift-jet V/STOL aircraft.

79. Chambers, J. R., Kirby, R. H., Flight Investigation of Dynamic Stability and Control Characteristics of a 0.18-Scale Model of a Fan-in-Wing VTOL Airplane, NASA TN D-3412 (N66-32941)

A free-flight investigation of a 0.18-scale model of the XV-5A was made to study the stability and control characteristics during hovering flight, both in and out of ground effect and fan-powered low-speed forward flight. Data were obtained mainly from pilot observations and from studies of motion picture records of the flights.

81. Hall, L. P., Hickey, D. H., Kirk, J. V., Aerodynamic Characteristics of a Large-Scale V/STOL Transport Model with Lift and Lift-Cruise Fans, NASA TN D-4092, Aug. 1967 (N67-33454)

A wind tunnel test of two configurations of a V/STOL transport model powered by tip-turbine-driven fans. First configuration was combination of two lift fans and two rotating cruise fans. Second configuration consisted of four tandem mounted lift fans. Both configurations used a high-mounted wing with an aspect ratio of 5.8, swept back 35° at the quarter-chord line, and a taper ratio of 0.30. Aerodynamic characteristics, including force and moment data, were obtained for the hover and low forward speeds. Some fan exit pressures and wing surface pressure distributions were also measured during the tests.

82. Hall, L. P., Hodder, B. K., Kirk, J. V., Large-Scale Wind Tunnel Investigation of a V/STOL Transport Model with Wing-Mounted Lift Fans and Fuselage Mounted Lift-Cruise Engines for Propulsion, NASA TN D-4233, Nov. 1967 (N67-40198)
The low-speed aerodynamic characteristics of a large-scale fan-in-wing V/STOL transport model were investigated. The model had six fans mounted in the wing and two lift-cruise engines mounted forward of the wing in the fuselage. The high mounted wing had an aspect ratio of 3.43, taper ratio of 0.47, and a 0.25 c sweepback of 20°. Combination of 2, 4, and 6 fans were investigated as well as the chordwise position of the fans in the wing to determine the interference effects of the flow field. The effects of operating two lift-cruise engines in conjunction with the six lift fans were also studied.

85. Chambers, J. R., Grafton, S. R., Static and Dynamic Longitudinal Stability Derivatives of a Powered 0.18-Scale Model of a Fan-in-Wing VTOL Aircraft, NASA TN D-4322, Feb. 1968 (N68-15894)
An investigation was conducted to determine the static and dynamic longitudinal stability derivatives of a powered 0.18-scale model of the XV-5A for trimmed level flight at an angle of attack of 0°. The investigation covered a range of values of thrust and oscillatory frequencies for the model with the horizontal tail both on and off.

106. Anon, Estimated Dynamic Stability Characteristics, G. E. Report No. 151, Sept. 1964 (AD 639 235)

This report presents the dynamic stability characteristics of the XV-5A lift-fan research aircraft based on theoretical and empirical estimates of dynamic stability derivatives and static aerodynamic characteristics derived from scale model wind tunnel tests. Except for a presentation of the lift fan natural damping contributions to flight in the lift-fan mode, the report is restricted to analysis of conventional flight characteristics.

147. Parks, W. C., Swingle, R. L., Swope, W. A., XV-5A Aerodynamic Propulsion Data Correlation and Characteristics Development Based on Wind Tunnel Characteristics, Ryan Report No. 29467-1, July 1968 (AD 676 862)

This report contains the results of a wind tunnel and thrust stand data correlation and characteristics generation program using data from tests of the XV-5A lift fan research aircraft. The program efforts were limited to the lift-fan mode of operation and were restricted to correlation of longitudinal test data and to development of longitudinal stability characteristics for calculated flight conditions. Data from five wind tunnel programs (majority of data correlation utilized results from the Ryan 1/6-scale and NASA full-scale model tests) provided the primary basis for the work. Longitudinal stability derivatives for the XV-5A were developed and numerical values were calculated for the fan mode of operation.

151. Anon, Wind Tunnel Test Report Conventional Model. Volume II. Low-Speed Pressure and Hinge Moments, G. E. Report No. 141-Vol. II, Jan. 1964 (AD 653568)

This report presents the results from wind tunnel tests of a 1/8-scale conventional model of the XV-5A ($M = 0.285$). Hinge moment coefficients and pressure data in plotted and tabular form with pertinent detail explanatory information are presented.

152. Anon, One-Fifth-Scale Inlet Model Wind Tunnel Test Report, Volume II, G. E. Report No. 154-Vol. II, March 1965 (AD 617 395)

This report contains the tabulated pressure data from the low speed tests ($M = 0$ to $M = 0.2$) of the XV-5A 1/5-scale inlet model.

153. Anon, Wind Tunnel Test Report, Lift Fan Powered Scale Model,
G. E. Report No. 137, Nov. 1963 (AD 647 386)
This report presents the results of wind tunnel tests of a 1/6-scale powered model of the XV-5A. Data were obtained to define the static characteristics in and out of ground effect; aerodynamic characteristics in forward flight for the transition, conversion, and low speed conventional flight modes; and flight characteristics at low translational speeds near hovering in vertical, lateral, and rearward directions. In addition, wing surface static pressures and wing fan inlet closure door hinge moments were measured.

154. Anon, Estimated Static Stability and Control Characteristics,
G. E. Report No. 146, March 1964 (AD 639 236)
This report contains the estimated static stability and control characteristics of the XV-5A. The estimates are based on theoretical and empirical considerations, including the results of 420 hours of wind tunnel tests of 1/8- and 1/6 scale models, and also data from tests of a full-scale model similar to the XV-5A.

155. Anon, Phase I Flight Tests Results, Volume II, G. E. Report No. 166, Volume II, March 1965 (AD639 232)
This report presents the conventional flight test results (wing-supported lift) of the XV-5A aircraft test program which was conducted by the contractor. Contents include flight test plots on thermodynamics, airplane stall performance, climb performance, static longitudinal stability, static and dynamic lateral-directional stability, and also control effectiveness.

156. Anon, Final Systems Analysis and Flight Simulation Report, Volume II, G. E. Report No. 157, Volume II, March 1965 (AD 639 230)
This report presents the results and details of the XV-5A simulation and analysis for the hover, transition, and conversion modes of operation.

166. Przedpelski, Z. J., Results of Wind Tunnel Tests of a Full-Scale, Fuselage Mounted, Tip Turbine Driven Lift Fan. Volume III, G. E. Report No. TR 61 15 V3, March 1962 (AD 275 711)
This report presents the results of wind tunnel tests of a full-scale

VTOL airplane model with a fan-in-fuselage power plant. The model had a shoulder-mounted unswept wing with an aspect ratio of 5.0 and taper ratio of 0.50. Contents include powered and unpowered performance in and out of ground effect, static longitudinal stability, and STOL performance. Reference No. 71 presents NASA data for same tests.

159. Anon, Results of Wind Tunnel Tests of a Full-Scale Fuselage Mounted, Tip Turbine Driven Lift Fan, Volume II, G. E. Report TR 61 15 V2, April 1961 (AD 263 450)
This report presents the results of wind tunnel tests for the same test program as Reference no. 166. The contents include more conventional flight data than Reference 166, no ground effect, and emphasis on the J85-7 generator performance.

177. LaPlant, P. C., Flight Evaluation of the XV-5A V/STOL Aircraft, AFFTC-TR-66-30, March 1967 (AD 810 922)
This report presents the results of a USAF flight evaluation of the XV-5A aircraft. The primary emphasis is placed on the handling qualities. Stability and control characteristics are presented for the hover (in and out of ground effect), level flight performance, transition regime, and STOL operation.

178. Anon, Wind Tunnel Test Report Conventional Model, Volume III. High Speed (Mach = 0.4 to 0.9), G. E. Report No. 141, Volume III, Jan. 1964 (AD 653 569)
This report presents the results of the high speed ($M = 0.4$ to $M = 0.9$) wind tunnel tests of the 1/8-scale conventional model of the XV-5A. Six-component data plus wing and fuselage static pressure data are contained in the report. Control surface hinge moment coefficients are also presented.

179. Anon, Wind Tunnel Test Report Conventional Model, Volume I. Low Speed Force and Moment Data, G. E. Report No. 141, Volume I, Jan. 1964 (AD 653 566).
This report presents the results of the low speed ($M = 0.285$) wind tunnel tests of the 1/8-scale conventional model of the XV-5A. Static longitudinal, lateral, and directional stability characteristics are presented along with the control effectiveness parameters.

180. Anon, Phase I Flight Test Results, Volume I, G. E. Report No.

166, Volume I, March 1966 (AD 639 231)

This report presents the results of flight tests on the XV-5A conducted by the contractor. The major portion of the tests is centered on the fan-powered speed regime (hover to transition); performance, stability and control (in and out of ground effect), and tail downwash are included in the report's experimental plotted data.

182. Anon, Preliminary Pilot Qualitative Evaluation of the XV-5A

Research Aircraft, AATA-AFB-Letter Report, Oct. 1965

(AD 623 514)

This report presents the results of the U. S. Army's Aviation preliminary pilot evaluation of the XV-5A. Contents include pilot's comments on the performance and handling qualities during hovering (in and out of ground effect), transition, and conversion speed regimes. Some experimental data are presented.

186. Anon, Results of Wind Tunnel of a Full-Scale Wing-Mounted Tip-

Turbine-Driven Lift Fan, ATRECOM TR 63-21, Sept. 1963

(AD 426 785)

This report presents the results of wind tunnel tests of a full-scale fan-in-wing model. The tests are the same as the tests of Reference 39. However, the results are more concerned with the fan characteristics than the external aerodynamic characteristics reported in Reference 39. Tabulated plus plotted data are presented.

189. Aoyagi, K., Hickey, D. H., deSavigny, R. A., Aerodynamic

Characteristics of a Large-Scale Model with a High Disk-Loading

Lifting Fan Mounted in the Fuselage, NASA TN D-775, Oct. 1961

AD 265 252)

This report presents the results of wind tunnel tests of a large-scale fan-in-fuselage model. The longitudinal characteristics, static pressure survey and horizontal tail downwash are presented for the hovering and transition speed regimes, all out of ground effect. The model is the same as the one used in Reference 71; these tests were conducted prior to Reference 71.

192. Maki, R. L., Hickey, D. H., Aerodynamics of a Fan-in-Fuselage Model, NASA TN D-789, May 1961 (AD 256 074)
This report presents a limited analysis of the longitudinal test results of Reference 189. The primary emphasis is centered on the large pitching-moment variation with increase in flight speed. Very little qualitative and/or quantitative data are presented.

200. Anon, Full-Scale Wind Tunnel Test Report, G. E. Report No. 153, June 1966 (AD 654 043)
This report presents the results of full-scale XV-5A aircraft wind tunnel tests performed at NASA Ames. The contents include power on and power off plotted data for the static longitudinal characteristics, the static lateral and directional characteristics, control effectiveness, and static engine thrust stand parameters.

207. Ferrell, K. R., Finnestad, R. L., et al, Engineering Flight Research Evaluation of the XV-5A, Part I - Stability and Control, Final Report, USAATA Report, 1966 (AD 800 937L)
This report presents the results of the U. S. Army Aviation's engineering flight research evaluation of the XV-5A. The flying qualities and the stability and control characteristics of the XV-5A are evaluated in detail, qualitatively and quantitatively. Complete plotted data in terms of time history and control displacements are presented for the fan-mode and jet-mode speed regimes. Pilots' opinions are given for each aerodynamic stability and control criteria.

261. Hickey, D. H., Hall, L. P., Aerodynamic Characteristics of a Large-Scale Model with Two High Disk-Loading Fans Mounted in the Wing, NASA TN D-1650, Feb. 1963
Model has a shoulder-mounted wing of A. R. = 3.5. Results cover the fan-powered flight speed range from 0 to 100 knots. Longitudinal forces and moments, pressure distributions, and lateral forces and moments when the fans were throttled to give control are presented. Installed fan performance over the pertinent speed range is presented for three inlets and with and without fan exhaust vectoring.

2. LIFT-JET CONCEPT

An examination of Table IV reveals that the major testing conducted on this V/STOL concept was centered on the XV-4A and XV-4B. It is emphasized at this point that the results of this literature survey are based on the reports available and known to exist at this time. The DDC and NASA literature search services were employed in this study. There are probably contractors' test reports, both in the United States and foreign countries, which are proprietary and therefore unavailable. Consequently, only the available, existing reports are discussed in this literature survey.

The normal six-component force and moment data have been measured for the hover (in and out of ground effect), transition, and conventional speed regimes. There has been no static pressure survey around the lift-jet or surrounding areas in order to identify the local flow field in a complete configuration model.

There is a limited amount of analysis on the dynamic stability derivatives, and a small amount of flight test data (all of these data are presented for the XV-4A, which employs an augmented jet ejector and not a lift jet).

Abstracts of Lift-Jet Concept Reports

5. Kuhn, R. E., McKinney, M. O., Reeder, J. P.; Aerodynamics and Flying Qualities of Jet V/STOL Airplanes, SAE Paper 864A, April 1964 (A64-20157)

A summary of information on airplane aerodynamics, ground effects, propulsion system aerodynamics, stability and control, and flying qualities of jet V/STOL airplanes (both direct jet lift and lift-fan configurations) is presented.

30. Otis, J. H., Jr., Induced Interference Effects on a Four-Jet VTOL Configuration with Various Wing Planforms in the Transition Speed Range, NASA TN D-1400, 1962 (N62-15319)

Wind tunnel results of a limited investigation with a simplified model at zero angle of attack to study the jet interference effects in transition from hovering to forward flight out of ground effect. A series of wings (5) were tested with a fuselage employing four convergent nozzles to provide some preliminary data on the effects of planform. Lift losses and nose-up pitching moments were encountered at low forward speeds.

TABLE IV. SUMMARY OF LIFT-JET EXPERIMENTAL DATA

CHAPTER 10

41. Anon, Aerodynamics of Power Plant Installation, AGARDograph-103, 1965 (N66-22286)
A compilation of technical papers presented at the 1965 AGARD meeting on The Aerodynamics of Power Plant Installation, Part 2. Contents include discussions on air inlets and nozzles, airframe-propulsion system interference, VTOL propulsion including jet lift intakes and exhausts, also lift-fan inlets and airframe VTOL propulsion interference effects.

59. Shupert, P. K., Tibbetts, J. G., Model Tests on Jet Induced Lift Effects on a VTOL Aircraft in Hover, NASA CR-1297, March 1969 (69-21477)
Jet-induced interference effects were investigated for a jet aircraft in hovering flight using a scale model with numerous nozzle configurations (18) and model components. Interference loads and jet decay data were obtained in and out of ground effect to determine the effects of various parameters on interference loads and to assess a technique for correlating lift loss with jet decay characteristics.

78. Anon, Conference on V/STOL and STOL Aircraft, NASA SP-116, April 1966 (N66-24606)
A compilation of papers presented at the 1966 NASA Conference on V/STOL Aircraft. Contents include discussions covering the results of NASA research on problems associated with V/STOL aircraft, such as, aerodynamics and propulsion of helicopters and propeller V/STOL. also lift-fan and lift-jet V/STOL aircraft.

80. Hickey, D. H. and Kirk, J. V., Full-Scale Wind Tunnel Investigation of a VTOL Aircraft with a Jet-Ejector System for Lift Augmentation, NASA TN D-3725, Nov. 1966 (67-32321)
Wind tunnel results of a full-scale XV-4A airplane to determine its aerodynamic characteristics, including its ejector system, ejector performance, longitudinal characteristics, lateral-directional stability and control, and control power about all three axes were determined at various airspeeds and control settings through the transition flight regime.

87. Gentry, G. L. and Margason, R. J., Aerodynamic Characteristics of a Five Jet VTOL Configuration in the Transition Speed Range, NASA TN D-4812, Oct. 1968 (68-36021)
A wind tunnel investigation of a powered small-scale model of a VTOL fighter configuration having three lift-jet engines in the forward fuselage and two deflected lift-cruise engines in the aft fuselage was conducted to determine the aerodynamic characteristics in the transition speed range and also ground effect during hover. The model was tested with three wing configurations and up to three horizontal tail heights.

88. Winston, M. M., Wind Tunnel Data from a 0.16-Scale V/STOL Model with Direct-Lift and Lift-Cruise Jets, NASA TM X-1758, March 1969 (N69-20016)
Wind tunnel results of a 0.16-scale XV-4B model to determine its aerodynamic characteristics. Six cold air ejectors were used to simulate four direct-lift and two lift-cruise jet engines. Longitudinal and lateral-directional aerodynamic characteristics were investigated for various model configurations, forward speeds, and power conditions in the transition and cruise flight ranges. In addition to control-effectiveness studies, the effects of power variations for different lift-nozzle settings and the effects of height above the ground were investigated. The data are presented without analysis.

123. Williams, J., Wood, M., Aerodynamic Interference Effects with Jet-Lift V/STOL Aircraft under Static and Forward-Speed Conditions, RAE-TR-664-3, Dec. 1966 (AD 813 258)
The nature and magnitude of aerodynamic interference effects which can arise with jet and fan-lift schemes for V/STOL aircraft are considered. Particular attention is paid to adverse flows which can be induced around the airframe by the jet or fan efflux during V/STOL operation near the ground and during transition to and from purely wing-borne flight. The discussion concentrates on the understanding and analysis of major aerodynamic features rather than on optimization of specific aircraft layouts.

150. Anon, Full-Scale Tests of the XV-4A Hummingbird in the Ames 40 x 80 Foot Wind Tunnel, G. E. Report No. ER-7634, Jan. 1965 (AD 654 783)

The results of the XV-4A Hummingbird tests in the Ames 40 x 80 foot wind tunnel (Reference 80) are presented and analyzed. The 41 runs made included pitch, yaw, and control effectiveness tests in hover, transition, and conventional flight.

181. Nicholson, R., Lowry, R. B., XV-4A VTOL Research Aircraft Program, USA-AVLABS TR-66-45, May 1966 (AD 635 106)

This report contains a description of the XV-4A aircraft and highlights the aircraft design characteristics, aircraft systems, flight test program, VTOL improvement program, and wind tunnel tests.

208. Martin, W. O., Low-Speed Wind Tunnel Test Results of a 0.18-Scale Model of the XV-4A, Lockheed-Georgia Report ER 8677, 1966

This report presents the results from a wind tunnel test of a proposed modification to the XV-4A airplane. The 0.18-scale model was tested in the LTV low-speed wind tunnel. Six-component force and moment data were recorded for the hover through transition flight regimes. Six nozzles in the bottom of the model fuselage were employed to simulate the exhaust of six jet engines. No analysis is presented.

209. Whipkey, R. R., XV-4B Wind Tunnel Tests of a 0.16-Scale Model in the NASA Langley 7 x 10 Foot Wind Tunnel, Lockheed-Georgia Report ER 9092, 1967

This report presents the contractor's results from a wind tunnel test of a 0.16-scale XV-4B model. Six-component data are presented for the hover, transition, and conversion speed regimes. Horizontal stabilizer and elevator effectiveness, rudder and aileron effectiveness, with and without power, in and out of ground effect, are also presented. Very little analysis is presented.

257. Swain, W. N., Wind Tunnel Test of a 0.16-Scale XV-4B Model in the NASA Langley 17-Foot Low Speed Wind Tunnel and the 7 x 10 Foot High Speed Wind Tunnel, Lockheed-Georgia Report No. ER 9061, Sept. 1968

This report presents the contractor's results from two wind tunnel

tests of a 0.16-scale XB-4B model at NASA Langley. The first phase was conducted in a low speed tunnel to determine the power effects on the aerodynamic characteristics in the conventional, STOL, and hover modes of flight. Six-component force and moment data were obtained in both pitch and sideslip. Ground effects were determined for several model attitudes. The second phase was conducted in the high speed tunnel to determine the aerodynamic characteristics in the conventional flight regime (unpowered). Six-component force and moment data were acquired in both pitch and sideslip.

3. VECTORED THRUST CONCEPT

An examination of Table V reveals that only a small amount of experimental testing has been conducted on the complete configurations of this V/STOL concept. Of the tests conducted, six-component force and moment data were obtained for the hover (in and out of ground effect), transition, and conventional speed regimes. Noticeably missing are static pressure surveys and tail downwash surveys.

Abstracts of Vectored Thrust Concept Reports

23. Wood, M. N., Jet V/STOL Aircraft Aerodynamics, New York Academy of Sciences, Annals, Vol. 154, Nov. 1968 (A69-15566)
This paper presents a discussion of results of the V/STOL Aerodynamic Research Program carried out in the low-speed tunnel's division of the Royal Aircraft Establishment. Some experimental aerodynamic data are presented for the P-1127 model and some stability data are presented for the Short S. C. -1 model.
34. Spreeman, K. P., Investigation of Interference of a Deflected Jet with Free Stream and Ground on Aerodynamic Characteristics of a Semispan Delta-Wing VTOL Model, NASA TN D-915 (N62-71489)
This report presents the results from a NASA wind tunnel test of a semispan delta wing VTOL model with a deflected jet under the wing. Sets of vanes attached to the wing behind the jet deflected the jet stream to different turning angles. Static tests were run in and out of ground effect. Longitudinal aerodynamic characteristics were obtained for various angles of attack and deflection angles.

TABLE V. SUMMARY OF VECTORED THRUST EXPERIMENTAL DATA

REFERENCE NUMBER	VECTORED THRUST LOCATION	WING ASPECT RATIO	WING TAPER RATIO	WING SWEEP DEGREE	TAIL VOLUME FINENESS RATIO	CONCLUDING THRUST NOZZLE	ARATIO TO WING THRUST	MODEL SCALE	a RANGE-DFG	SPEED RANGE-DFG	POWER EFFECTS	DOWNWASH STRIKE	LATERAL STABILITY	DIRECTIONAL STABILITY	NASA semi-span Delta wing VTOL model with deflected jet under wing.	TEST CONDITIONS		TEST DATA		COMMENTS
																TEST	DATA	TEST	DATA	
34 1961	W 3 n0	3stab	0.143	37.	9.0	None	2	0.025	Small	-40 to 0	0.6	33.9	H, T, C	0.10	Yes	Yes	Yes	Yes	No	NASA semi-span Delta wing VTOL model with deflected jet under wing.
24 1961	W 1.55	Slab	0.443	37.	9.0	0.24	2	0.0305	Small	-40 to +8	0 to 0.6	33.9	H, T, C	0.50	Yes	Yes	Yes	Yes	No	NASA semi-span Delta wing VTOL model with deflected jet under wing.
117 1968	F 2.80	NPL .0/5.5	34.	6.9	0.525	4	0.0502	Full	Vary	0 to 165	H, T, C	Un-known	Yes	Yes	Yes	Yes	Yes	Yes	P-1127 (X-16A) flight tests by USAF Flight Test Center.	
143 1968	F 2.61	NACA 0.059	44.	4.6	None	1	None	0.20	0 to +10	-90 to +90	47.5	C	3.10	No	Yes	Yes	Yes	No	Short SC-1 roll stability tests at low speeds.	
197 1957	F 3.00	Un-known	0.50	13.	5.9	N/A	3	0.028	Small	0	0	H	0	Yes	Yes	Yes	Yes	No	Static tests of two NASA VTOL models.	
213 1964	Nac 5.48	Un-known	0.613	0.0	16.62	8.68	6	0.0292	0.13	-10 to 0	0 to +20	94.5	H, T, C	Un-known	Yes	Yes	Yes	Yes	No	Freeflight and force tests of combined vector thrust and lift jet.
233 1965	F 4.52	NACA 0.69	65/A012	Vary	6.2	Variable	4	0.044	Small	-10 to -25	0 to +10	10.0	H, T	.18 to .47	No	Yes	Yes	Yes	No	NASA tests of variable-sweep Delta wing model.
269 1967	F 6.15	NACA 0.48	23014	-4	6	5.4	0.55	2	Un-known	-12 to 0	0 to +90	1.22	H, T	Un-known	Yes	Yes	Yes	Yes	No	X-14 NASA, AMES unpublished wind tunnel preliminary tests.

41. Anon, Aerodynamics of Power Plant Installation, Agardograph-103, 1965 (N66-22286)
A compilation of technical papers presented at the 1965 Agard meeting on The Aerodynamics of Power Plant Installation, Part 2. Contents include a paper on the X-14A VTOL Flight Test and some data on the P-1127.

91. Winters, C. P., The Approximate Longitudinal Stability Derivatives of a Vectored Thrust VTOL, AFIT Report No. GAM/AE/68-11, March 1968 (AD 833 396)
This report presents the results of an analytical study to determine the stability derivatives and the stability of the vectored thrust airplane, P-1127. The performance, derivatives and stability were determined for both an accelerating and non-accelerating transition from hover to conventional flight. The results of the accelerating transition were compared to values available from Hawker Siddeley.

117. McKinzie, G. A., Bradfield, E. N., Jr., Ludwig, J. H., Casey, W. R., P-1127 (XV-6A) V/STOL Handling Qualities Evaluation, AFFTC-TR-68-19, Aug. 1968 (AD 839 849)
This report presents the results of a flight test program conducted by the USAFFTC to evaluate the V/STOL flying and handling qualities of the P-1127 (XV-6A) aircraft. The static longitudinal and lateral-directional stability characteristics along with the control effectiveness are presented for the hover (in and out of ground effect) and transition flight regimes. In addition, the dynamic longitudinal and lateral-directional stability characteristics are presented. Also, the rigid mount AFFTC VTOL thrust stand facility was utilized to evaluate the engine, nozzles, and flight control system in a simulated hover environment.

143. Trebble, W. J. G., Low-Speed Wind Tunnel Investigation of the Roll Stability of a 1/5-Scale Model of the Short SC-1 at Large Sideslip, ARC-CP-994, May 1967 (AD 837 313)
This report presents the results of a low-speed wind tunnel test on a 1/5-scale model of the Short S.C. -1. The test was conducted primarily to determine the roll characteristics of the model at

large sideslip angles. Lateral and directional forces and moments are presented for various air speeds and sideslip angles.

197. Newsom, W. A., Jr., Effect of Ground Proximity on Aerodynamic Characteristics of Two Horizontal-Attitude Jet Vertical-Take-Off-and-Landing Airplane Models, NASA TN D-419, Sept. 1957 (AD 144 809)

This report presents the results of a static simulated power test of two jet VTOL models. One model was a tilt-wing and the other was a deflected jet in the fuselage. Tuft studies and some force data are presented. Cascade vanes were employed to obtain the thrust vectoring.

213. Smith, C. C., Parlett, L. P., Flight Tests of a 0.13-Scale Model of a Vectored-Thrust Jet VTOL Transport Airplane, NASA TN D-2285, 1964

This report presents the results of an experimental investigation to determine the dynamic and control characteristics of a 0.13-scale model of a vectored thrust jet VTOL transport airplane. The model has a straight wing mounted on top of the fuselage and is powered by two vectored-thrust turbofan engines mounted in nacelles under the wing (four rotating thrust nozzles per nacelle) and six turbojet lift engines mounted in wing tip pods with three engines in each pod. Free-flight tests were conducted in hover (in and out of ground effect) and transition with motion picture recordings. Static longitudinal and later-directional characteristics are presented from wind tunnel force tests.

235. Vogler, R., Kuhn, R. E., Longitudinal and Lateral Stability Characteristics of Two Four-Jet VTOL Models in the Transition Speed Range, NASA TM X-1092, May 1965

This report presents the results of a NASA investigation of the longitudinal and lateral stability characteristics of two four-jet vectored thrust type VTOL models in the transition speed range. The basic model investigated had a low aspect ratio delta wing with variable-sweep auxiliary wings, twin inlets, and four adjustable exit nozzles. The modified model was obtained by removing the delta wing area rearward of the jet exits of the basic model and adding a

conventional horizontal tail. Six component data were obtained for both models from hover to conventional flight speed range.

269. Anon, Unpublished NASA Wind Tunnel Data on Preliminary Tests of the X-14 at NASA, Ames, 1967

These unpublished data present the results of preliminary tests of the XV-14A in the NASA 40 x 80 foot wind tunnel. Force and moment data have been obtained for power on and off conditions and $\psi = 0^\circ$ and 90° .

APPENDIX
SUMMARY OF V/STOL REFERENCES

KEY TO V/STOL SUMMARY TABLE (See Table VI)

COLUMN HEADING	ABBREVIATION	DEFINITION
V/STOL Concept	LF LJ VT TD TW TP	Lifting Fan Lifting Jet Vectored Thrust Tilting Duct Tilting Wing Tilting Propeller
Nature of Report Material	A E	Analytical or Theoretical Experimental
Flight Regime or Airflow	H T C LOW	Hover Transition Cruise Low Speed Near Hover
Test Article (Component)	W B T J DP FP D-FAN I W, B, T	Wing Body Tail Jet Ducted Propeller Flat Plate Ducted Fan Inlet Total Configuration
Types of Test	WT FT BT SIMUL HT	Wind Tunnel Test Flight Test or Free-Flight Bench Test Simulator Hydrodynamic Test

TABLE VI. SUMMARY TABLE OF V/STOL REFERENCES

TABLE VI. (Continued)

TABLE VI. (Continued)

REFERENCE NUMBER		YEAR OF PUBLICATION		CONCERN		NATURE OF REPORT		FLIGHT REGIME OR AIRFLOW		TEST ARTICLE		TESTS		TYPE OF TEST		TEST RESPONSE		CHARGE EFFECT		BODY AERODYNAMICS		GEOMETRY		V/STOL EFFECTS		INTERFERENCE		AERODYNAMICS		LATERAL DYNAMIC		DYNAMIC		MANUFACTURER & CONTROL		AREAS OF INVESTIGATION OR ANALYSIS	
107	1965	TW	A	H, T	W, B, T	None																															
108	1964	LF, LJ, VT	A	H, T, C	DP	None																															
109	1964	TD	A, E	H, T, C	DP	W																															
111	1963	TW	A	W	None																																
117	1968	VT	E	H, T, C	W, B, T	WT																															
120	1968	LJ	A, S	H, T	W, B	WT																															
122	1967	LJ	A	H, T	W, B	None																															
123	1966	LF, LJ, VT	A, E	H, T, C	W, B, T	WT																															
126	1968	VT	A, E	T	W, B, T	Simul																															
127	1967	LF	A, E	H, T, C	W	WT																															
128	1966	TW, TD	A	H, T	W, B, T	Simul																															
131	1966	TJ	E	H, T	D-FAN	WT																															
132	1965	TJ	E	H, T	D-FAN	WT																															
133	1964	VT	A	T	D-FAN	WT																															
134	1964	TJ	E	H, T	D-FAN	WT																															
143	1967	VT	E	T	W, B, T	WT																															
144	1968	TD	A, E	H, T	W, B, T	WT																															
145	1967	LJ	E	H	Jet	WT																															
146	1967	LJ	E	H	Jet	WT																															
147	1968	LF	A, E	H, T	W, B, T	WT																															
148	1968	LJ	A	H	Jet	WT																															
149	1967	LF, LJ, VT	A, E	H, T, C	W, B, T	WT																															
150	1965	LJ	E	H, T, C	W, B, T	WT																															
151	1964	LF	E	LOW	W, B, T	WT																															
152	1965	LJ	E	H, T, C	Inlet	WT																															
153	1963	LJ	E	H, T, C	W, B, T	WT																															
154	1964	LJ	A, E	H, T, C	W, B, T	WT																															
155	1966	LF	E	H, T, C	W, B, T	WT																															

TABLE VI. (Continued)

REFERENCE NUMBER	YEAR OF PUBLICATION	V/STOL CONCEPT	NATURE OF ARTICLE	FLIGHT REGIME OR AIRPLANE	TEST ARTICLES	TESTS	INLET EFFECTS	GROUP EFFECT	WING EFFECT	ALCOHOL INTERFERENCE	C/STOL PERFORMANCE	C/STOL DYNAMIC	LATENT-DETECTION	DYNAMIC	ROTARY	SAILABILITY & CONTROL		
																1965	1965	1965
156	1965	LF	A, E	H, T, C	W, B, T	Simul										X	X	X
159	1965	LF	A, E	T	W, B, T	Simul										X	X	X
160	1965	LJ	E	H	WB	BT	X	X	X							X	X	X
162	1964	LF	E	H, T	W, B, T	WT, FT	X	X	X							X	X	X
163	1964	LJ	E	H	W, B	BT	X	X	X							X	X	X
164	1964	LJ, LF	E		WT	X	X	X	X							X	X	X
165	1963	LJ	E	H, T	W	WT		X	X							X	X	X
166	1962	LF	A, E	H, T	W, B, T	WT	X	X	X							X	X	X
168	1961	LF	A, E	H, T	W	WT	X	X	X							X	X	X
169	1961	LF	E	H, T, C	W, B, T	WT	X	X	X							X	X	X
177	1967	LF	E	H, T, C	W, B, T	FT	X									X	X	X
178	1964	LF	E	C	W, D, T	WT										X	X	X
179	1964	LF	E	LOW	W, D, T	WT										X	X	X
180	1966	LF	E	H, T, C	W, B, T	FT										X	X	X
181	1966	LJ	E	H, T, C	W, B, T	FT, WT										X	X	X
182	1965	LF	E	H, T, C	W, B, T	FT										X	X	X
184	1964	LJ	E	H	W	WT		X	X							X	X	X
186	1963	LF	E	H, T, C	W, B, T	WT	X	X	X							X	X	X
189	1961	LF	E	H, T	W, B, T	WT										X	X	X
193	1961	LF, VT	E	T	W, B	WT										X	X	X
200	1966	LF	E	H, T, C	W, B, T	WT										X	X	X
203	1968	LJ, VT	A, E	H	W, B	WT		X	X	X						X	X	X
204	1969	Any	A	??	W	None										X	X	X
206	1969	LJ	A	H	Jet	None										X	X	X
207	1966	LF	E	H, T, C	W, B, T	FT										X	X	X
208	1966	LJ	E	H, T	W, B, T	WT										X	X	X

TABLE VI. (Continued)

		Areas of Investigation or Analysis									
		Stability & Control					DYNAMIC				
REFERENCE NUMBER	YEAR OF PUBLICATION	CONCEPT		TEST APPROXIMATION		TEST APPROXIMATION		TEST APPROXIMATION		TEST APPROXIMATION	
		VISCOELASTIC	PLASTICITY	ELASTIC	ELASTIC	ELASTIC	ELASTIC	ELASTIC	ELASTIC	ELASTIC	ELASTIC
209	1967	LJ	E	H, T, C	W, B, T	WT	X	X	X	X	X
210	1960	LJ	E	H	W, B	BT	X	X	X	X	X
211	1963	LJ	E	T	FP	WT	X	X	X	X	X
213	1964	VT	A, E	H, T	W, B, T	FT	X	X	X	X	X
214	1964	LJ	E	H, T	W, B	WT	X	X	X	X	X
216	1966	LJ	E	H	W, B	WT	X	X	X	X	X
217	1966	LJ	E	T	W, B	WT	X	X	X	X	X
219	1967	LJ	E	H, T	W, B, T	WT	X	X	X	X	X
220	1962	LJ	E	H	W	BT	X	X	X	X	X
221	1958	LJ	E	H	W, B, T	BT	X	X	X	X	X
223	1966	LJ	E	H	FP	BT	X	X	X	X	X
224	1966	ALL	A, E	H, T	B, FP	BT	X	X	X	X	X
225	1964	ALL	A, E	T, C	B	WT	X	X	X	X	X
226	1964	LJ	A, E	H, T	W	WT	X	X	X	X	X
227	1966	LJ	A, E	H, T	W	WT	X	X	X	X	X
228	1967	LJ	A, E	H, T	W	WT	X	X	X	X	X
229	1968	LJ	A, E	H, T	W, B	WT	X	X	X	X	X
230	1969	LF, LJ	A, E	T	W, B, T	WT	X	X	X	X	X
231	1969	LJ	A, E	H	Jet	WT	X	X	X	X	X
232	1967	LJ	A, E	H	FP	BT	X	X	X	X	X
233	1967	Any	A, E	H	W	WT	X	X	X	X	X
234	1965	Any	A, E	H	B	WT	X	X	X	X	X
235	1965	LJ, VT	E	T	W, B, T	WT	X	X	X	X	X
236	1947	Any	A, E	T, C	W	WT	X	X	X	X	X
237	1952	Any	A, E	T, C	W	WT	X	X	X	X	X
238	1948	Any	A	T, C	W	None	X	X	X	X	X
239	1947	Any	A	T, C	W	None	X	X	X	X	X

TABLE VI. (Concluded)

REFERENCE NUMBER	YEAR OF CONSTRUCTION	PUBLICATION NUMBER	REPORT. NAME	FLIGHT REGIME	TEST ARTICLE (COMPONENT)	TESTS OF TEST ARTICLE	WING EFFECTS (EFFECTS)	WING ALONE	BODY ALONE	INTERFERENCE EFFECTS	GENERAL V/STOL	ROTARY DYNAMIC	LATERAL-DYNAMIC	STABILITY & CONTROL	Areas of Investigation or Analysis									
															1958	1955	1959	1957	1955	1963	1965	1967	1959	
240	1958	Any	A, E	H, T, C	W	WT										X	X							
241	1955	Any	A, E	H, T, C	W	WT										X	X							
242	1959	Any	A, E	H, T	B	WT										X	X							
243	1957	Any	A, E	H, T, C	W, B, T	WT										X	X							
244	1955	Any	A			None										X	X							
245	1963	LJ	A, E	H	FP	WT										X	X							
250	1965	LF	A	H	W	None										X	X							
251	1967	LJ	A, E	H	W	WT										X	X							
252	1958	LJ	A, E	H	W	WT										X	X							
253	1959	LF	A, E	H	W	WT										X	X							
254	1957	LF	A, F	H	W	WT										X	X							
255	1961	LJ	A, E	H	W	WT										X	X							
256	1969	LJ	A, E	H	W, B	WT										X	X							
257	1968	LJ	E	H, T, C	W, B, T	WT										X	X							
258	1968	Any	A, E	Any	Any	WT										X	X							
259	1969	Any	A, E	Any	B	WT										X	X							
263	1968	Any	A, E	H, T	All	WT, FT										X	X							
264	1969	LJ	E	H, T	B	WT										X	X							
265	1969	Any	A	H, T	FP	WT										X	X							
266	1968	LJ	E	H	W, B, T	WT										X	X							
267	1959	LF	E	H	W	WT										X	X							
268	1960	LF	A	H, T, C	Any	None										X	X							
269	1967	VT	E	H, T	W, B, T	WT										X	X							
270	1969	LJ	E	H, T	W	WT										X	X							
271	1968	LJ, VT	A, E	H, T	FP	WT										X	X							
272	19C9	LJ, VT	A, E	H, T	FP	WT										X	X							
274	1969	LJ, VT	A, E	H, T	FP	WT										X	X							
275	1968	LJ, VT	A, E	H, T	FP	WT										X	X							

REFERENCES

1. Norland, Sven-Anders, An Investigation Of The Lift Produced By A Fan in a Two-Dimensional Wing, American Helicopter Society Journal, Vol. 7, Oct 1962, (A63-10240)
2. Brady, W. C. and Ludwig, G., Theoretical and Experimental Studies Of Impinging Uniform Jets, American Helicopter Society Journal, Vol. 8, April 1963, (A63-17411)
3. Holden, K. J., The Effects of Introducing a Restoring Moment Proportional to Stick Velocity on the Hovering Of An Unstabilized Jet-Lift Aircraft, Aeronautical Quarterly, Vol. 15, Feb 1964, (A64-15303)
4. Martin, E. E., The Lift Produced by a Wing Mounted Lift Fan at Flight Speeds Below Transition, American Helicopter Society, Vol. 9., April 1964, (A64-17616)
5. Kuhn, R.E., McKinney, M.O., Reeder, J.P., Aerodynamics and Flying Qualities of Jet V/STOL Airplanes, SAE Paper 864A, Apr 1964, (A64-20157)
6. Hacker, T., Problems of Dynamics and Control of the VTOL Aircraft, ICAS Paper 64-566, Aug 1964, (A64-21689)
7. Schaub, U. W., Cockshutt, E. P., Analytic and Experimental Studies of Normal Inlets, With Special Reference to Fan-in Wing VTOL Power-Plants, ICAS Paper 64-572, Aug 1964, (A64-22756)
8. Hill, T.G., Some Fundamentals for Efficient VTOL Aircraft Hover Control, American Helicopter Society Journal, Vol. 2, Jan 1966, (A66-23258)
9. Iakovelskii, O. V., Krasheninnikov, S. Iu., Propagation of a Turbulent Jet Colliding with a Flat Surface, Mekhanika Zhidkosti I Gaza, Jul-Aug 1966, (A66-41737)
10. Herbst, W., Calculation of the Aerodynamic Coefficients of a Finite Fan-in-Wing Airfoil, VDI Zeitschrift, Vol. 108, No. 27, 1966, (A66-43050)

11. Wolkovitch, J., An Introduction to Hover Dynamics, SAE Paper 660576, Aug 1966, (A67-10570)
12. Kentfield, J.A., Nozzles for Jet-Lift V/STOL Aircraft, Journal of Aircraft, Vol. 4, July-Aug 1967, (A67-32569)
13. Williams, J., Wood, M.N., Aerodynamic Interference Effects with Jet-Lift V/STOL Aircraft Under Static and Forward-Speed, Zeitschrift Fuer Flugwissenschaften, Vol. 15, Jul 1967, (A67-36952)
14. Schaub, U.W., Fan-in-Wing Aerodynamics - Experimental Assessment of Several Inlet Geometries, AIAA Paper 67-746, Oct 1967, (A67-40980)
15. Hazen D.C., The Rebirth of Subsonic Aerodynamics, Astronautics and Aeronautics, Vol. 5., Nov 1967, (A68-10676)
16. Connors, A.J., Swaim, R.L., Gust Velocity Spatial Distribution Effects on Lateral-Directional Response of VTOL Aircraft, Journal of Aircraft, Vol. 5, Jan-Feb 1968, (A68-16600)
17. Schaffler, J., Basic Design of an All-Purpose V/STOL Transport Aircraft - The VC 400/ VC 400, Luftfahrttechnik Raumfahrttechnik, Vol. 14, Apr 1968, (A68-28722)
18. Rubbert, P.E., Saaris, G.R., A General Three-Dimensional Potential-Flow Method Applied to V/STOL Aerodynamics, SAE Paper 680304, Apr - May 1968, (A68-31326)
19. Theisen, J.G., V/STOL Stability and Control in Turbulence, American Meteorological Society, 1968, (A68-35131)
20. Coles, A.V., Control Characteristics of Vectored Thrust V/STOL Vehicles in the Transition Regime, American Helicopter Society Journal, Vol. 13, July 1968. (A68-37052)
21. Krenkel, A.R., Salzman, A., Takeoff Performance of Jet-Propelled Conventional and Vectored-Thrust STOL Aircraft, Journal of Aircraft, Vol. 5, Sept-Oct 1968, (A68-40369)
22. McKinney, M.O., Newsom, W.A., Fan V/STOL Aircraft, New York Academy of Sciences, Annals, Vol. 154, Nov 1968, (A69-15565)
23. Wood, M.N., Jet V/STOL Aircraft Aerodynamics, New York Academy of Sciences, Annals, Vol. 154, Nov 1968, (A69-15566)

24. Saito, T., Hamada, K., Hukuhare, Z., Kurata, T., Ohara, N., Dynamic Stability Tests of V/STOL Model, Mitsubishi Technical Review. Vol. 5, No. 5, 1968 (A69-17091)
25. Ramnath, R. V., Transition Dynamics of VTOL Aircraft, AIAA Paper 69-130, 1969, (A69-18157)
26. Curtiss, H. C., Jr., Dynamic Stability of V/STOL Aircraft at Low Speeds, AIAA Paper 69-194, 1969, (A69-19566)
27. Gregory, N. and Walker, W. S., Measurements of Lift and Ground Interference on a Lifting-Fan Wing at Zero Forward Speed, ARC-R&M-3263, 1962, (N62-10193)
28. Mort, K. W. and Yaggy, Paul F., Aerodynamic Characteristics of a Four-Foot Diameter Ducted Fan Mounted on the Tip of a Semispan Wing, NASA TN D-1301, 1962, (N62-11045)
29. Hung-Shen, Y-UNG-C, Theoretical Analysis of Jet-Ground Plane Interaction, IAS Paper 62-144, June 1962, (N62-13384)
30. Otis, J. H. Jr., Induced Interference Effects on a Four-Jet VTOL Configuration with Various Wing Planforms in the Transition Speed Range, NASA TN D-1400, 1962, (N62-15319)
31. Kuhn, R. E., Review of Basic Principles of V/STOL Aerodynamics, NASA TN D-733, 1961, (N62-71307)
32. Sarpkaya, T., An Analytical Study of Separated Flow About Circular Cylinders, Journal of Basic Engineering, December 1968, pp. 511-520
33. Kalman, J. and Grunwald, J., Aerodynamic Characteristics of a Four-Propeller Tiltwing VTOL Model with Twin Vertical Tails, Including Effects of Ground Proximity, NASA TN D-901, June 1961, (N62-71475)
34. Spreeman, K. P., Investigation of Interference of a Deflected Jet with Free Stream and Ground on Aerodynamic Characteristics of a Semispan Delta-Wing VTOL Model, NASA TN D-915, (N62-71489)
35. Martin, J. E., Dynamic Load Problems Associated With V/STOL Aircraft, Proceedings of the Cal/Trecom Symp., 1963, (N63-20359)

36. Hall, L. P., Hickey, D. H., Kirk, J. V., Aerodynamic Characteristics of a Full-Scale Fan-in-Wing Model Including Results in Ground Effect With Nose-Fan Pitch Control, NASA TN D-2368, (N64-28323)
37. Williams, J., Comments on Some Recent Basic Research on V/STOL Aerodynamics, RAE-TN-AERO-2795, Nov 1961, (N65-29640)
38. Kuhn, R. E., McKinney, M. O. Jr., NASA Research on the Aerodynamics of Jet VTOL Engine Installation, NASA TM-X-56820, 1965, (N65-34998)
39. Kuhn, R. E., McKinney, M. O. Jr., Reeder, J. P., Aerodynamics and Flying Qualities of Jet V/STOL Airplanes, NASA TM-X-51421, (N65-89049)
40. Stapleford, R. L., Wolkovitch, J., Johnson, W. A., Magdaleno, R. E., Shortwell, C. P., An Analytical Study of V/STOL Handling Qualities in Hover and Transition, TR-140-1, AFFDL-TR-65-73, (AD-625599), 1965 (N66-16671)
41. Anon., Aerodynamics of Power Plant Installation, Agardograph-103, 1965, (N66-22286)
42. Henderson, C., Hesby, A., Kroll, J., Control Characteristics of V/STOL Aircraft in Transition, Bell Report 2023-917002, (N66-81695)
43. Goldberger, S., On the Relative Importance of the Low Speed Control Requirement For V/STOL Aircraft, AEDC-TR-66-205, 1966, (N67-20708) (AD-644191)
44. Goodson, K. W., Ground Effects on a Four-Propeller Tilt-Wing Configuration Over a Fixed and a Moving Ground Plane, NASA TN D-3938, 1967, (N67-23820)
45. Przedpelski, Z. J., Lift Fan Technology Studies, NASA CR-761, 1967, (N67-25046)
46. Strand, T., Inviscid-Incompressible Flow Theory of Normal and Slightly Oblique Impingement of a Static Round Jet on the Ground, AROD-5274-3, 1967, (AD-648500) (N67-26496)
47. Murphy, R. D., Powered Model Investigation of the Effects of Ground Spoilers on the Aerodynamic Characteristics of Wings at Angles of Attack From 0 Degrees to 90 Degrees, NSRDC-2406, 1967 (AD-655248), (N67-36940)

48. Daniels, J. R., Hiles, J. D., Flow Near Lifting Jets Close to the Ground, Bristol Univ. Report No. 60 (B.S. Thesis), 1961, (N67-80224)
49. Anon., Aerodynamic Problems Associated with V/STOL Aircraft, Vol. IV CAL Symposium, 1966, (AD-657565), (N67-86801)
50. Anon., Aerodynamic Problems Associated with V/STOL Aircraft, Vo. II CAL Symposium, 1966 (AD-657563)(N67-86835)
51. Holland, C.H., Strand, T. and Yager, P.M., Modified Weissinger Lifting Surface Method for Calculating Aerodynamic Parameters of Arbitrary Wing-Canard Configuration, AVC Report 354, 1967, (AD-660423), (N68-11230)
52. Anon., Meeting Report of the WGLR Technical Committee on Aerodynamics, DLR MITT-67-18, 1967, (N68-13982)
53. Hertel, H., Wall Flow and Flow Impingements From the Deviation of Free Jet Groups, NASA-TT-F-11670, 1966, (N68-23519)
54. Anon., Aspects of V/STOL Aircraft Development, Agard-Advisory-13, 1967, (N68-23761)
55. Ermolenko, S. D., Nonlinear Theory of Small Aspect Ratio Wings, Soviet Aeronautics, No. 2, 1966, pp. 9-18
56. Weinig, F.S., Airfoil Theory of the Wing Installed Lifting Fan and Comparison with Test Results, G.E. RPT., 1961, (N68-87797)
57. Lieblein, S. and Stockman, N.O., Theoretical Analysis of Flow in VTOL Lift Fan Inlets Without Crossflow, NASA TN D-5065, Feb 1969, (N69-17831)
58. Yager, P.M., Holland, C.M., Levinsky, E.S., Thommen, H.U., Lifting Surface Theory and Tail Downwash Calculations for V/STOL Aircraft in Transition and Cruise, USAALVLABS- TR- 68-67, 1968, (AD-680969), (N69-20533)
59. Shumpert, P.K., Tibbetts, J.G., Model Tests of Jet Induced Lift Effects On a VTOL Aircraft in Hover, NASA-CR-1297, Mar 1969, (N69-21477)

60. Goldsmith, R., Hickey, D., Characteristics of Aircraft with Lifting-Fan Propulsion Systems for V/STOL, IAS Paper No. 63-27, Jan 1963, (A63-11581)
61. Corden, C. D., and Everett, W. L., Simulation Approach to Development of the XV-5A Lift-Fan V/STOL Aircraft, SAE Paper No. 755A, Sept 1963, (A63-25844)
62. Kirby, R. H., Test Techniques Used by NASA for Investigating Dynamic Stability Characteristics of V/STOL Models, American Inst. of Aeronautics and Astronautics, 1964, (A64-14526)
63. Pokorny, V., The Effects of Nonlinearities in Lift and Pitching-Moment Curves on Longitudinal Motion of an Aircraft, Zprava Vzlu, Dec 1964, (A66-26285)
64. Williams, J., Recent Basic Research on V/STOL Aerodynamics at R.A.E., Ministry of Aviation, Zeitschrift Fuer Flugwissenschaften, Vol. 14, June, 1966, (A66-35364)
65. Meager, G., Canada's Entry in the New Family of Large Wind Tunnels for V/STOL Aircraft Development, Engineering Inst. of Canada, Congress of Canadian Engineers, May-June 1967, (A68-12525)
66. Barrack, J. P., Kirk, J. V., Low-Speed Characteristics of High-Performance Lift-Engine V/STOL Aircraft, SAE Paper 680644, (A68-45072)
67. Templin, R. J., Recent Trends in Low-Speed Wind-Tunnel Design and Techniques, ICSA, New York Academy of Sciences, Annals, Vol. 154., Nov 1968, (A69-15573)
68. Gates, S. B., and Griggs, C. F., An Analysis of Some VTOL Transition Motions, RAE-TN-AERO-2596, (N62-11968)
69. Trebble, W. and Williams, J., Exploratory Wind Tunnel Investigations on a Bluff Body Containing a Lifting Fan, RAE-TN-AERO-2754, (N62-15845)
70. Grasmann, K., Jet Deflection for the Purpose of Thrust Vector Control in S/VTOL Aircraft, Scient. Soc. For Avia., Annual Meeting, Paper No. 29, Oct 1962, (N63-10027)

71. deSavigny, R.A. and Hickey, D.H., Aerodynamic Characteristics in Ground Effect of a Large-Scale Model with a High Disk-Loading Lifting Fan Mounted in the Fuselage, NASA-TN-D-1557, Jan 1963, (N63-11617)
72. Koenig, D.G., Low Speed Tests of Semispan-Wing Models at Angles of Attack from 0° to 180°, NASA Memo 2-27-59A, April 1959
73. Anon., NASA Conference on V/STOL Aircraft, Compilation of the papers presented at Langley Research Center, Nov 1960, (N63-14683)
74. Anon., AIAA Aerodynamic Testing Conference, 1964, (N64-17013)
75. Davenport, E.E. and Kuhn, R.E., Wind-Tunnel-Wall Effects and Scale Effects on a VTOL Configuration with a Fan Mounted in the Fuselage, NASA-TN-D-2560, Jan 1965, (N65-13574)
76. Trebble, W.J.G., Wind-Tunnel Experiments on a Simple Lifting-Jet Body with and without Wings, ARC-CP-718, 1964 (N65-17894)
77. Kutyna, D.J., Low Speed Aerodynamic Characteristics of Jet VTOL Aircraft at Angles of Attack, MIT M.S. Thesis, May 1965, (AD-620442) (N66-11330)
78. Anon., Conference on V/STOL and STOL Aircraft, NASA-SP-116, Apr 1966, (N66-24606)
79. Chambers, J.R., Kirby, R.H., Flight Investigation of Dynamic Stability and Control Characteristics of a 0.18 Scale Model of a Fan-in-Wing VTOL Airplane, NASA-TN-D-3412, (N66-32941)
80. Hickey, D.H. and Kirk, J.V., Full-Scale Wind-Tunnel Investigation of a VTOL Aircraft with a Jet-Ejector System for Lift Augmentation, NASA TN-D-3725, Nov 1966, (N67-32321)
81. Hall, L.P., Hickey, D.H., Kirk, J.V., Aerodynamic Characteristics of a Large-Scale V/STOL Transport Model with Lift and Lift-Cruise Fans, NASA TN-D-4092, Aug 1967, (N67-33454)
82. Hall, L.P., Hodder, B.K., Kirk, J.V., Large-Scale Wind-Tunnel Investigation of a V/STOL Transport Model with Wing-Mounted Lift Fans and Fuselage Mounted Lift-Cruise Engines for Propulsion, NASA-TN-D-4233, Nov 1967, (N67-40198)
83. Heyson, H.H., Some Considerations in Wind-Tunnel Tests of V/STOL Models, NASA-TM-X-60772, Sept 1967, (N68-13016)

84. Goethert, R., Inlet Measurements on a VTOL Aircraft Model, Brunswick/West Germany, 1967, (N68-13244)
85. Chambers, J. R., Grafton, S. B., Static and Dynamic Longitudinal Stability Derivatives of a Powered 0.18-Scale Model of a Fan-in-Wing VTOL Aircraft, (NASA-TN-D-4322), Feb 1968, (N68-15894)
86. Anon., Integration of Propulsion Systems in Airframes, AGARD CP-27, Sept 1967, (N68-28850)
87. Gentry, G. L. Margason, R.J., Aerodynamic Characteristics of a Five Jet VTOL Configuration in the Transition Speed Range, NASA TN-D-4812, Oct 1968 (N68-36081)
88. Winston, M. M., Wind-Tunnel Data From a 0.16 Scale V/STOL Model with Direct-Lift and Lift-Cruise Jets, NASA TM X-1758, Mar 1969, (N69-20016)
89. Anon., Bibliography of AFFTC Technical Publications and Presentations 1951-1964, AFFTC Report, 1965, (AD469630)
90. Lehmann, M.J.W., The Aerodynamic Characteristics of Non-Aerodynamic Shapes, AFIT Report GAM/AE/68-6, June 1968, (AD 838 823)
91. Winters, C.P., The Approximate Longitudinal Stability Derivatives of a Vectored Thrust VTOL, AFIT Report No. GAM/AE/68-11, March 1968, (AD 833 396)
92. Miller, D.P., Vinje, E.W., Fixed-Base Flight Simulator Studies of VTOL Aircraft Handling Qualities in Hovering and Low-Speed Flight, UACRL-F910482-12, Jan 1968, (AD 831 446)
93. Bramwell, A.R.S., Johnston, J.B.B., A Theory of the Aerodynamic Interference Between a Helicopter Rotor Blade and a Fuselage and Wing in Hovering and Forward Flight, ARC-R/M-3514, June 1965, (AD 827 631)
94. Fitch, C.R., Three Dimensional Aerodynamic Representation of V/STOL Wings by the Vortex-Lattice Method, AEDC-TR-68-6, Jan 1968, (AD 826 007)
95. Schulz, R.J., Simulation of Jet Entrainment in a Potential Field, AEDC-TR-217, Nov 1967, (AD 822 341)
96. Notess, C. B., Whitcomb, D. W., A Review and Study of Flying Qualities to Aid Design of a Variable Stability VTOL Aircraft, CAL-TE-1865-F-2, Dec 1963, (AD 816 032)

97. Perry, D.H., Chinn, H.W., A Preliminary Flight Simulation Study of Jet-Borne VTOL Aircraft Handling Qualities, ARC-CP-902, June 1965, (AD 809 892)
98. Skelton, B.G., Investigation of the Effects of Gusts on V/STOL Craft in Transition and Hover, Honeywell Report No. 12060-FRI, Oct 1968, (AD 679 593)
99. George, M., Kisielowski, E., Douglas, D.S., Investigation of the Downwash Environment Generated by V/STOL Aircraft Operating in Ground Effect, DCR-275, Jul 1968, (AD 674 644)
100. Skulsky, R. S., A Conformal Mapping Method to Predict Low-Speed Aerodynamic Characteristics of Arbitrary Slender Re-Entry Shapes, Journal of Spacecraft, Vol. 3, No. 2, February 1966, pp. 247-253
101. Hink, G.R., Gilbert, R.F., Sundstrom, K.A., General Method for Determining the Aerodynamic Characteristics of Fan-in-Wing Configurations, Vol. II, USAAVLABS TR-67-61B-V^L-2, Dec 1967, (AD 667 981)
102. Anon., Recommendations for V/STOL Handling Qualities with an Addendum Containing Comments on the Recommendations, AGARD-408A, Oct 1964, (AD 661 748)
103. Swaim, R. L., Connors, A. J., Effects of Gust Velocity Spatial Distributions on Lateral-Directional Response of a VTOL Aircraft, AFFDL-TR-67-93, June 1967, (AD 657 321)
104. Shields, R. T., Some Notes on United Kingdom Experience in the Testing of VTOL Aircraft, AGARD-318, April 1961, (AD 652 927)
105. Anon., Installed Systems Functional Test Summary, G.E. Report No. 148, March 1964, (AD 645 998)
106. Anon., Estimated Dynamic Stability Characteristics, G.E. Report No. 151, Sep 1964, (AD 639 235)
107. Curtiss, H.C., Jr., An Analytical Study of the Dynamics of Aircraft in Unsteady Flight, Princeton Univ. Aerospace/Mechanical Report No. SCI-709, Oct 1965, (AD 627 370)
108. Weitz, P., A Qualitative Discussion of the Stability and Control of VTOL Aircraft during Hover (Out of ground effect), and Transition, Naval Post-graduate School Report, 1964, (AD 622 205)

109. Kriebel, A.R., Theoretical Investigation of Static Coefficients, Stability Derivatives, and Interference for Ducted Propellers, ITEK Report No. 112, March 1964, (AD 602 269)
110. Lean, D., Chinn, H.W., Review of General Operating Experience With a Jet-Lift VTOL Research Aircraft (Short S.C.I.), AI C-CP-832, Aug 1963, (AD 479 413)
111. Cumberbatch, E., A Lifting Surface Theory for Wings at High Angles of Attack Extending Through Multiple Jets, VRC Report No. 9, 1963, (AD 423 274)
112. Trebble, W.J.G., Wind-Tunnel Experiments on a Simple Lifting-Jet Body With and Without Wings, RAE TN AERO 2882, March 1963, (AD 409 184)
113. McVeigh, M. A., Kisielowski, E., McHugh, J. G., A Design Summary of Stall Characteristics of Straight Wing Aircraft, NASA CR-1946, June 1971
114. Bradbury, L. J. S., Wood, M. N., The Static Pressure Distribution Around a Circular Jet Exhausting Normally from a Plane Wall into an Airstream, RAE Technical Note, AERO 2978, August 1964
115. Jones, A. G., Parameter Variation - an Insight to V/STOL Design, AIAA Paper No. 70-551, May 1970
116. MacCabe, R.S., Vertical Flight Performance Criteria, ACDCA Report, June 1968, (AD 840 304)
117. McKinzie, G.A., Bradfield, E.N., Jr., Ludwig, J.H., Casey, W.R., P-1127 (XV-6A) V/STOL Handling Qualities Evaluation, AFFTC-TR-68-10, Aug 1968, (AD 839 849)
118. Kellar, R.P., Green, D.C., A Preliminary Analysis of the XV-4B VTOL Aircraft Computer Simulation, AFIT Report No. GAM/AE-68-4, March 1968, (AD 838 777)
119. Bowne, N.E., Anderson, G.E., Takeoff and Landing Critical Atmospheric Turbulence (Tolcat) Analytical Investigation, AFFDL TR-68-23, March 1968, (AD 835 232)
120. Archino, D.T., Simplified Approximations of Interference Effects on Jet V/STOL Aircraft, AFIT Report No. GAM/AE/68-2, March 1968, (AD 833 270)

121. Kroll, J., Jr., Initial VTOL Flight Control Design Criteria Development, CAL-BB-2249-F-1, Oct 1967, (AD 825 471)
122. Templin, R.J., A Momentum Rule for Optimum Aircraft Performance in the V/STOL Transition Regime, NAE Report No. LR-470, 9639, Jan 1967, (AD 819 596)
123. Williams, J., Wood, M., Aerodynamic Interference Effects with Jet-Lift V/STOL Aircraft under Static and Forward-Speed Conditions, RAE-TR-66403, Dec 1966, (AD 813 258)
124. Hacker, T., Problems of the Dynamics and Control of VTOL Aircraft: Optimum Guidance and Stability, Library Translation RAE-1186, Oct 1966, (AD 810 440)
125. McGregor, D.M., The Influence of Aircraft Size on Control Power and Control Sensitivity Requirements, NAE-LR-459, Jul 1966, (AD 805 418)
126. McGregor, D.M., A Flight Investigation of Various Stability Augmentation Systems for a Jet-Lift V/STOL Aircraft (Hawker-Siddeley P1127) Using an Airborne Simulator, NAE-LR-500, Feb 1968, (AD 675 766)
127. Rubbert, P.E., Saaris, G., Scholey, M.B., et al, A General Method for Determining the Aerodynamic Characteristics of Fan-in-Wing Configurations, Volume I, Theory and Application, USAAVLABS TR-67-61A-VOL-1, Dec 1967, (AD 667 980)
128. Rampy, J.M., Important V/STOL Aircraft Stability Derivatives in Hover and Transition, AFFTC-TR-66-29, Oct 1966, (AD 641 371)
129. Johnston, J., Culver, I.H., Friend, C.F., Study of Size Effects on VTOL Handling Qualities Criteria, USAAVLABS TR-65-24, Sept 1965, (AD 622 578)
130. Mertaugh, L.J., Data Report for LTV Low Speed Wind Tunnel Test Number 172. Test of High Mass Rate Vectored Propulsion Flow Model, LTV 2-53310/5R-2172, Feb 1965, (AD 612 927)
131. Tyler, R.A., Williamson, R., Intake Flow and Fan Performance Measurements at High Thrust Loadings in Inclined Flow, NRC Report No. LR-453, May 1966, (AD 486 285)
132. Tyler, R.A., Williamson, R., Measured Circular Intake Performance in Inclined Flow for a Series of EMI-Circular LIP Profiles, NRC Report No. LR-424, Jan 1965, (AD 471 053)

133. Lang, J.A., Some Considerations of the Uses of Vectored Thrust, With Particular Reference to S.T.O.L. Operation, AAEE/RES/312, Sept 1964, (AD 460 638)
134. Tyler, R.A., Williamson, R.G., Pressure Loss and Flow Distortion Measurements on Circular Compressor Intakes in Inclined Flow, NRC LR-401, Apr 1964, (AD 453 166)
135. Dathe, H. M., Review of Hovering Control Requirements for VTOL Aircraft by a Flight Dynamics Analysis, AGARD 472, July 1963, (AD 438 878)
136. Dukes, T.A., Carballal, J.M., Lion, P.M., Some Dynamic Aspects of Stability in Low-Speed Flying Machines, ATRECOM TR63-56, Nov 1963, (AD 431 566)
137. Klug, H., Spintzyk, H., VTOL/STOL Aircraft -- First Supplement 1961/62, AGARD Report, 1963, (AD 427 826)
138. Anon., Recommendations for V/STOL Handling Qualities, AGARD 408, Oct 1962, (AD 410 323)
139. Wasson, H. R., Studies of a Method for Predicting Nonlinear Aerodynamics of Arbitrary Bodies, Northrop Report NOR 69-44, March 1969
140. Hackett, J. E., Cox, D. K., The Three-Dimensional Mixing Layer Between Two Grazing Perpendicular Streams, Journal of Fluid Mechanics, Vol. 43, Part 1, 1970, pp. 77-96
141. Hackett, J. E., Miller, H. R., A Theoretical Investigation of a Circular Lifting Jet in a Crossflowing Mainstream, AFFDL-TR-70-170, 1970
142. Seidel, M., Untersuchungen ueber den Einfluss eines geneigten Triebwerkstrahles auf die aerodynamischen Eigenschaften eines Leitwerks, Zeitschrift fuer Flugwissenschaften, Vol. 19, 1971, pp. 13-29
143. Trebble, W.J.G., Low-Speed Wind-Tunnel Investigation of the Roll Stability of a 1/5 Scale Model of the Short SC-1 at Large Sideslip, ARC-CP-994, May 1967, (AD 837 313)
144. Key, D. L., Reed, L. E., VTOL Transition Dynamics and Equations of Motion with Application to the X-22A, CAL-TB-2312-F-1, June 1968, (AD 835 996)

145. Cox, M., Abbott, W.A., Studies of the Flow Fields Created by Single Vertical Jets Directed Downwards upon a Horizontal Surface, ARC-CP-912, Oct 1967, (AD 813 962)
146. Abbott, W.A., Studies of Flow Fields Created by Vertical and Inclined Jets when Stationary or Moving over a Horizontal Surface, ARC-CP-911, Oct 1967, (AD 809 897)
147. Parks, W.C., Swingle, R.L., Swope, W.A., XV-5A Aerodynamic-Propulsion Data Correlation and Characteristics Development Based on Wind Tunnel Characteristics, Ryan Report No. 29467-1, July 1968, (AD 676 862)
148. Colin, P.E., The Wall Jet Beneath a Counter-Flowing Stream, Final Report VKIFD, March 1968, (AD 673 200)
149. Anon., Fluid Dynamics of Rotor and Fan Supported Aircraft at Subsonic Speeds, AGARD-CP-22, Sept 1967, (AD 669 226)
150. Anon., Full-Scale Tests of the XV-4A Hummingbird in the Ames 40 x 80 Foot Wind Tunnel, LAC Report No. ER-7634, Jan 1965, (AD 654 783)
151. Anon., Wind Tunnel Test Report Conventional Model. Volume II. Low-Speed Pressure and Hinge Moments, G.E. Report No. 141-VOL-2, Jan 1964, (AD 653 568)
152. Anon., One-Fifth Scale Inlet Model Wind Tunnel Test Report, Volume II, G.E. Report No. 154-Vol-2, March 1965, (AD 647 395)
153. Anon., Wind Tunnel Test Report, Lift-Fan Powered Scale Model, G.E. Report No. 137, Nov 1963, (AD 647 386)
154. Anon., Estimated Static Stability and Control Characteristics, G.E. Report No. 146, March 1964, (AD 639 236)
155. Anon., Phase I Flight Test Results, Volume II, G.E. Report No. 166-VOL-2, March 1966, (AD 639 232)
156. Anon., Final Systems Analysis and Flight Simulation Report, Volume II, G.E. Report No. 157-VOL-2, March 1965, (AD 639 230)
157. Davidson, J.K., LTV Low Speed Wind Tunnel Test Number 190, Follow-On Test of High Mass Rate Vectored Propulsion Flow Model, LTV Report No. 2-53310/5R-2217, July 1965, (AD 621 578)

158. Stancil, R.T., Mertaugh, L.J., Jr., Analysis of a Low Speed Wind Tunnel Test of a High Mass Rate Vectored Propulsion Flow Model, LTV Report No. 2-53310/4R-2166 (AD 613 198)
159. Kraft, R.M., Neville, R.W., An Analysis of the Stick Fixed Dynamic Stability of a Typical VTOL Aircraft During Transition Flight out of Ground Effect, Naval Post-Graduate School, (AD 475 341)
160. Zegaroski, B.A., Data Report for VTOL Inlet Temperature Rise and Lift Thrust Test Program, Bell Report No. 2099-928001, (AD 466 576)
161. McGregor, D.M., A Flight Investigation of the Influence of Various Levels of Dihedral Effect on V/STOL Aircraft Directional Handling Qualities, NRL Report No. LR-412, Nov 1964, (AD 461 879)
162. Anon., XV-5A Lift Fan Flight Research Aircraft, G.E. Progress Report No. 11, Oct 1964, (AD 461 455)
163. Zegaroski, B.A., A Generalized Experimental Study of Inlet Temperature Rise and Lift-Thrust of Jet VTOL Aircraft in Ground Effect, Bell Report No. 2099/928002, Sept 1964, (AD 447 906)
164. Williams, J., Butler, S.F.J., Further Developments in Low-Speed Wind-Tunnel Techniques for V/STOL and High-Lift Model Testing, RAE-TN-AERO-2944, Jan 1964, (AD 436 352)
165. Colin, P.E., Powered Lift Model Testing for Ground Proximity Effects, Report No. TCEA TN14. Oct 1963, (AD 426 498)
166. Przedpelski, Z.J., Results of Wind Tunnel Tests of a Full Scale, Fuselage Mounted, Tip Turbine Driven Lift Fan. Volume 3, G.E. Report No. TR61 15 V3, March 1962, (AD 275 711)
167. Heyson, H.H., Linearized Theory of Wind-Tunnel Jet-Boundary Corrections and Ground Effect for VTOL/STOL Aircraft, NASA TR-R-124, Dec 1962, (AD 269 611)
168. Brogan, E. Casey, G., Vertodyne Fan-in-Wing VTOL Aircraft, Boeing-Vertol Report No. R-254, 1961, (AD 265 569)
169. Anon., Results of Wind Tunnel Tests of a Full Scale Fuselage Mounted, Tip Turbine Driven Lift Fan, Volume 2, G.E. TR61 15 V2, April 1961, (AD 263 450)

170. Huston, R. J., Winston, M. M., Data from a Static-Thrust Investigation of a Large-Scale General Research VTOL-STOL Model in Ground Effect, NASA TN D-397, Aug 1960, (AD 241 018)
171. Ricou, F. P., Spalding, D. B., Measurements of Entrainment by Axisymmetrical Turbulent Jets, Journal of Fluid Mechanics, Vol. 11, 1961, pp. 21-32
172. Margason, R. J., Gentry, G. L., Static Calibration of an Ejector Unit for Simulation of Jet Engines in Small-Scale Wind-Tunnel Models, NASA TN D-3867, March 1967
173. Kamotani, Y., Graber, I., Experiments on a Turbulent Jet in a Cross Flow, NASA CR-72893, June 1971
174. Anon., Viscous Mixing of Two-Dimensional Jets with Particular Reference to Jets in Ground Proximity, AT&T ECOM TR-64-11, April 1964
175. Symons, E. P., Labus, T. L. Experimental Investigation of an Axisymmetric Fully Developed Laminar Free Jet, NASA TN D-5304, April 1971
176. Newsom, W. A., Jr., Grafton, S. B., Flight Investigation of a V/STOL Transport Model having Six Wing-Mounted Lift Fans, NASA TN D-6198, April 1971
177. LaPlant, P. C., Flight Evaluation of the XV-5A VSTOL Aircraft, AFFTC-TR-66-30, Mar 1967, (AD 810 922)
178. Anon., Wind-Tunnel Test Report Conventional Model, Volume III. High Speed (Mach = 0.4 to 0.9), G. E. Report No. 141-VOL-3, Jan 1964, (AD 653 569)
179. Anon., Wind Tunnel Test Report Conventional Model. Volume I. Low Speed Force and Moment Data, G. E. Report No. 141-VOL-1, Jan 1964, (AD 653 566)
180. Anon., Phase I Flight Test Results, Volume I, G. E. Report No. 166-Vol-1, March 1966, (AD 639 231)
181. Nicholson, R., Lowry, R. B., XV-4A VTOL Research Aircraft Program, USAAVLABS TR-66-45, May 1966, (AD 635 106)
182. Anon., Preliminary Pilot Qualitative Evaluation of the XV-5A Research Aircraft, AATA-AFB-Letter Report, Oct 1965, (AD 623 514)

183. Newsom, W.A., Jr., Grafton, S. B., Flight Investigation of a V/STOL Transport Model with Four Pod-Mounted Lift Fans, NASA, TN D-6129, February 1971
184. Peake, D.J., The Pressures on a Surface Surrounding a Jet Issuing Normal to a Mainstream, NRL Report No. LR-410, Nov 1964, (AD 463 295)
185. Tyson, J.J., Jr., Patterson, G.A., Flight Evaluation of Entwicklungsring Sud Hovering Rig, ONR Report No. TR1 65, Jan 1965, (AD 455 567)
186. Anon., Results of Wind Tunnel Tests of a Full-Scale Wing-Mounted Tip-Turbine-Driven Lift Fan, ATRECOM TR 63-21, Sept 1963, (AD 426 785)
187. Garren, J.F., Jr., Effects of Coupling Between Pitch and Roll Control Inputs on the Handling Qualities of VTOL Aircraft, NASA TN D-1233, March 1962, (AD 273 086)
188. Martinez, E., A New Facility for the Study of Aircraft Dynamics, Princeton University Report, (AD 256 941)
189. Aoyagi, K., Hickey, D.H., Desavigny, R.A., Aerodynamic Characteristics of a Large-Scale Model with a High Disk-Loading Lifting Fan Mounted in the Fuselage, NASA TN D-775, Oct 1961, (AD 265 252)
190. Patterson, J.C., Jr., Flechner, S.G., Jet Wake Effect of a High-Bypass Engine on Wing-Nacelle Interference Drag of a Subsonic Transport Airplane, NASA TN D-6067, November 1970
191. Innis, R.C., Quigley, H.C., A Flight Examination of Operating Problems of V/STOL Aircraft in STOL-Type Landing and Approach, NASA TN-D-862, June 1961, (AD 257 800)
192. Maki, R.L., Hickey, D.H., Aerodynamics of a Fan-in-Fuselage Model, NASA TN D-789, May 1961, (AD 256 074)
193. Spreeman, K.P., Induced Interference Effects on Jet and Buried-Fan VTOL Configurations in Transition, NASA TN D-731, 1961, (AD 253 303)
194. Drinkwater, F.J., III, Operational Technique for Transition of Several Types of V/STOL Aircraft, NASA TN D-774, 1961, (AD 252 988)
195. Anderson, S.B., An Examination of Handling Qualities Criteria for V/STOL Aircraft, NASA TN D-331, July 1960, (AD 241 025)

196. Crim, A.D., Hovering and Low Speed Flying Qualities of VTOL Aircraft, Bureau of Naval Weapons Report, (AD 223 528)
197. Newsom, W.A., Jr., Effect of Ground Proximity on Aerodynamic Characteristics of Two Horizontal-Attitude Jet Vertical-Take-Off- and-Landing Airplane Models, NASA TN-D-419, (AD 144 809)
198. Faliarski, M. D., Mort, K. W., Large Scale Wind Tunnel Investigation of a Ducted-Fan-Deflected-Slipstream Model with an Auxiliary Wing, NASA TN D-6323, April 1971
199. Winston, M. M., Induced Interference Effects on the Aerodynamic Characteristics of a .16-Scale Six-Jet V/STOL Model in Transition, NASA TN D-5727, March 1970
200. Anon., Full Scale Wind Tunnel Test Report, G.E. Report No. 153, June 1966, (AD 654 043)
201. Loftin, L. K., Jr., Airfoil Section Characteristics at High Angles of Attack, NACA TN 3241, August 1954
202. Loftin, L. K., Jr., Smith, H. A., Aerodynamic Characteristics at 15 NACA Airfoil Sections of Seven Reynolds Numbers from 0.7×10^6 to 9.0×10^6 , NACA TN 1945, October 1949
203. Carriere, Pierre, Effects of Internal Flow on The Aerodynamic Behavior of a Jet Aircraft, ICAS Paper 68-03, 1968, (A68-41248)
204. Sagner, M., Baudu, N., Induced Aerodynamic Field by a Plate Moving Rapidly At a Velocity Normal to Its Plane In An Atmosphere Initially At Rest, Academy of Sciences (Paris), Series A - Mathematical Sciences, Vol. 268, No. 12, March 1969, (A69-26288)
205. O'Leary, C.O., Flight Measurements of Ground Effect on the Lift and Pitching Moment of a Large Transport Aircraft and Comparison with Wind Tunnel and Other Data, RAE TR 68185, 1968, (X69-14888)
206. Bowley, W.W., Sucec, J., Trajectory and Spreading of a Turbulent Jet in the Presence of a Crossflow of Arbitrary Velocity Distribution, ASME Paper 69-GT-33, 1969, (A69-22491)
207. Ferrell, K.R., Finnestad, R. L. et al, Engineering Flight Research Evaluation of the XV-5A, Part I - Stability and Control, Final Report, USAATA Report, 1966, (AD 800973L)

208. Martin, W. O., Low-Speed Wind Tunnel Test Results of a 0.18 Scale Model of the XV-4A, Lockheed-Georgia Report ER 8677, 1966
209. Whipkey, R.R., XV-4B Wind Tunnel Test of a 0.16 Scale Model in the NASA Langley 7 x 10 Foot Wind Tunnel, Lockheed-Georgia Report ER 9092, 1967
210. Davenport, E. E., Spreemann, K. P., Thrust Characteristics of Multiple Lifting Jets in Ground Proximity, NASA TN D-513, 1960
211. Vogler, R. D., Surface Pressure Distributions Induced on a Flat Plate by a Cold Air Jet Issuing Perpendicularly From the Plate and Normal to a Low-Speed Free-Stream Flow, NASA TN D-1629, 1963
212. Higgins, C.C., Wainwright, T. W., Dynamic Pressure and Thrust Characteristics of Cold Jets Discharging from Several Exhaust Nozzles Designed for VTOL Downwash Suppression, NASA TN D-2263, 1964
213. Smith, C. C., Parlett, L. P., Flight Tests of a 0.13 Scale Model of a Vectored-Thrust Jet VTOL Transport Airplane, NASA TN D-2285, 1964
214. Vogler, R. D., Interference Effects of Single and Multiple Round or Slotted Jets on a VTOL Model in Transition, NASA TN D-2380, 1964
215. Rolls, L. S., Drinkwater, F. J., Innis, R. C., Effects of Lateral Control Characteristics on Hovering a Jet Lift VTOL Aircraft, NASA TN D-2701, 1965
216. Gentry, G. L., Margason, R. J., Jet-Induced Lift Losses on VTOL Configurations Hovering in and out of Ground Effect, NASA TN D-3166, 1966
217. Vogier, R. D., Ground Effects on Single and Multiple Jet VTOL Models at Transition Speeds Over Stationary and Moving Ground Planes, NASA TN D-3213, 1966
218. Spreemann, K. P., Free-Stream Interference Effects on Effectiveness of Control Jets Near the Wing Tip of a VTOL Aircraft Model, NASA TN D-4084, 1967
219. Hammond, A. D., McLemore, H. D., Hot-Gas Ingestion and Jet Interference Effects for Jet V/STOL Aircraft, NASA Paper AGARD Flight Mechanics Panel Meeting. Sept. 1967
220. Wyatt, L. A., Static Tests of Ground Effect on Planforms Fitted With a Centrally Located Round Lifting Jet, Ministry of Aviation C.P. 749, 1962
221. Spreemann, K. P., Sherman, I. R., Effects of Ground Proximity on the Thrust of a Simple Downward-Directed Jet Beneath a Flat Surface, NACA TN 4407, 1958

222. Schulz, G., Viehweger, G., Secondary Forces on a VTOL Plane During Hovering and Transition, Taking Account of Ground Effects, DVL Paper No. 851, 1967
223. McLemore, H.C., Jet-Induced Lift Loss of Jet VTOL Configurations in Hovering Condition, NASA TN D-3435, 1966
224. Sarpkaya, T., Separated Flow About Lifting Bodies and Impulsive Flow About Cylinders, AIAA Journal, March, 1966
225. Rodgers, E.J., Vorticity Generation of a Body of Revolution at an Angle of Attack, Journal of Basic Engineering, December 1964
226. Wooler, P.T., Calculation of the Forces on a Wing Due to a Circular Jet Exhausting from the Lower Surface of a Wing Into a Uniform Stream, PhD Thesis, University of Manchester, England, May 1964
227. Wooler, P.T., The Flow Past a Circular Jet Exhausting Normally From a Plane Wall or Wing Into a Uniform Airstream, Northrop Report NOR 66-278, August 1966
228. Wooler, P.T., Burghart, G.H., Gallagher, J.T., Pressure Distribution on a Rectangular Wing with a Jet Exhausting Normally Into an Airstream, J. of Aircraft, Vol. 4, No. 6, Nov-Dec 1967, pp 537-543
229. Schwantes, E., The Propulsion Jet of a VTOL Aircraft, 38th Meeting of AGARD Propulsion and Energetics Panel, September 1971
230. Grahame, W.E., Aerodynamic Effects of Lift-Jet and Lift-Fan Inlets in Transition Flight, Journal of Aircraft, Vol. 6, No. 2, March-April 1969 pp. 150-155
231. Wooler, P.T., Flow of a Circular Jet Into a Cross Flow, Journal of Aircraft, Vol. 6, No. 3, May-June 1969, pp. 283-284
232. Hall, G.R., Scaling of VTOL Aerodynamic Suckdown Forces, Journal of Aircraft, Vol. 4, No. 4, July-August 1967
233. Wasson, H.R., Mehus, T.E., A Segmented Wing Test Technique for Obtaining Spanwise Loading Distributions, Journal of Aircraft, Vol. 4, No. 4, Jul-Aug 1967
234. Schindel, L.H., Effect of Vortex Separation on Lifting Bodies of Elliptic Cross Section, M.I.T. TR 118, September 1965

235. Vogler, R., Kuhn, R.E., Longitudinal and Lateral Stability Characteristics of Two Four-Jet VTOL Models in the Transition Speed Range, NASA TM X-1092, May 1965

236. Weissinger, J., The Lift Distribution of Swept-Back Wings, NACA TM 1120, March 1947

237. Sivells, J.C., Westrick, G.C., Method For Calculating Lift Distribution For Unswept Wings With Flaps or Ailerons By Use of Non-linear Section Lift Data, NACA TR 1090, 1952

238. DeYoung, J., Harper, C.W., Theoretical Symmetric Span Loading at Subsonic Speeds for Wings Having Arbitrary Plan Form, NACA TR 921, 1948

239. Sivells, J.C., Neely, R.H., Method For Calculating Wing Characteristics By Lifting-Line Theory Using Non-linear Section Lift Data, NACA TR 865, 1947

240. Anderson, R.F., The Experimental and Calculated Characteristics of 22 Tapered Wings, NACA TR 627, 1938

241. Critzos, C.C., Heyson, H.H., Boswinkle, R.W., Aerodynamic Characteristics of NACA 0012 Airfoil Section At Angles of Attack From 0° to 180°, NACA TN 3361, January 1955

242. Bryson, A.E., Symmetrical Vortex Separation on Circular Cylinders and Cones, Journal of Applied Mechanics, Vol. 26, No. 4, December 1959, PP. 643-648

243. Pitts, W.C., Nielsen, J.N., Kaatari, G.E., Lift and Center of Pressure of Wing-Body-Tail Combinations At Subsonic, Transonic, and Supersonic Speeds, NACA TR 1307, 1957

244. Schwabe, M., Pressure Distribution In Non-Uniform Two-Dimensional Flow, Ingenieur-Archiv, Vol. VI, No. 1, February 1935, NACA TM 1039

245. Keffer, J.F., Baines, W.D., The Round Turbulent Jet In a Cross Wind, Journal of Fluid Mechanics, Vol. 15, PP. 481-496, 1963

246. Gelb, G.H., Martin, W.A., An Experimental Investigation of the Flow Field About a Subsonic Jet Exhausting Into a Quiescent and a Low Velocity Air-Stream, Northrop Report NOR 65-229, 1965, and Canadian Aeronautics and Space Journal, Vol. 12, No. 8, October 1966

247. Cahn, M.S., Stevens, J.R., Andrew, G.M., Garcia, J.R., Stability Derivatives by Rheoelectric Analog, Journal of Aircraft, Vol. 3, November-December 1966

248. Kroeger, R.A., Martin, W.A., The Streamline Matching Technique for V/STOL Wind Tunnel Wall Corrections, AIAA 5th Aerospace Sciences Meeting, New York, January 1967

249. Shofner, F.M., Menzel, R., Russell, T.G., Fundamentals of Holographic Velocimetry, AFFDL-TR-68-140, November 1968

250. Monical, R.E., A Method of Representing Fan-Wing Combinations For 3-D Potential Flow Solutions, Journal of Aircraft, Vol. 2, No. 6, November-December 1965, PP. 527-530

251. Wooler, P.T., On The Flow Past A Circular Jet Exhausting At Right Angles From A Flat Plate Or Wing, Journal of RAS, Vol. 71, March 1967, PP. 216-218

252. Jordinson, R., Flow in a Jet Directed Normal to the Wind, Aeronautics Research Council R&M 3074, 1958

253. Gregory, N., Ramer, W.G., Wind Tunnel Tests On The Boulton Paul Rectangular Wing (AR-2) With Lifting Fan, Series I, A.R.C. 20356, 1958, Series II, A.R.C. 21127, 1959

254. Gregory, N., Ramer, W.G., Wind Tunnel Test On The Effects Of The Apex Fan On A Swept Wing Project For VTOL With Three Lifting Fans, A.R.C. 21260, 1957

255. Wooler, P.T., Lift and Moment Forces Due To A Jet Ejected From The Lower Surface Of A Wing, English Electric Aero Research Report No. 8, 1961

256. Skifstad, J.G., Aerodynamics of Jets Pertinent To VTOL Aircraft, AFAPL-TR-69-28, March 1969

257. Swain, W.N., Wind Tunnel Test Of A 0 16 Scale XV-4B Model In The NASA Langley 17-Foot Low Speed Wind Tunnel And The 7 x 10-Foot High Speed Wind Tunnel, Lockheed-Georgia Report No. ER 9061, September 1968

258. USAF Stability And Control Handbook (Datcom), USAFFDL (No No.), Revised August 1968

259. Royal Aeronautical Society Data Sheets, Aerodynamics, Vol. 4, Bodies, Latest Revision

260. Royal Aeronautical Society Data Sheets, Aerodynamics, Vol. 2, Wings, Latest Revision
261. Hickey, D. H., Hall, L. P., Aerodynamic Characteristics of a Large-Scale Model with Two High Disk-Loading Fans Mounted in the Wing, NASA TN-1650, February 1963
262. Anon., The Aerodynamics of V/STOL Aircraft, AGARDograph 126, May 1968
263. Schwanes, E., Uebersicht ueber den Bodeneffekt bei strahlgestuetzten V/STOL Flugzeugen, DLR-Mitteilung 68-28, 1968
264. Hall, G. R., Scaling of VTOL Recirculation Phenomena, paper presented at the AFFDL V/STOL Technology and Planning Conference, September 1969
265. Epshtain, A., Zlobin, V., Design Model of a Jet in a Crosswind, EESTI NSV, Teaguste Akadeemia, Vol. 18, No. 2, 1969
266. Lavi, R., Hall, G. R., Stark, W. W., Full-Scale Ground Proximity Investigation of a VTOL Fighter Model Aircraft, NASA CR-1098, June 1968
267. Hickey, D. H., Ellis, D. R., Wind-Tunnel Tests of a Semi-Span Wing with a Fan Rotating in the Plane of the Wing, NASA TN D-88, October 1959
268. Theodorsen, T. H., Theoretical Investigation of the Ducted Propeller Aerodynamics, Vol. I, Republic Aviation Report, August 1960
269. Anon., Unpublished data on X-14 wind tunnel tests, NASA Ames Research Center, 1966
270. Carter, A. W., Effects of Jet-Exhaust Location on the Longitudinal Aerodynamic Characteristics of a Jet V/STOL Model, NASA TN D-5333, July 1969
271. Platten, J. L., Keffler, J. F., Entrainment in Deflected Jets at Various Angles to the Stream, University of Toronto Mech. E. -TP 6808, June 1968
272. Shandorov, G. S., Calculation of the Axis of a Jet in a Cross Flow, Soviet Aeronautics, Vol. 9, No. 2, 1969, pp. 100-104
273. Abramovich, G. N., The Theory of Turbulent Jets, M. I. T. Press, Cambridge, Mass., 1963
274. Wu, J. C., McMahon, H. M., Mosher, D. K., Wright, M. A., Experimental and Analytical Investigations of Jets Exhausting into a Deflecting Stream, Journal of Aircraft, Vol. 7, No. 1, January-February 1970, pp. 44-51

275. Margason, R. J., The Path of a Jet Directed at Large Angles to a Subsonic Free Stream, NASA TN D-4919, 1968

276. Chang, H. C., Aufrollung eines Zylindrischen Strahles Durch Querwind, Doctoral Dissertation, Univ. of Goettingen, 1942

277. Hall, G. R., Rogers, K. H., Recirculation Effects Produced by a Pair of Heated Jets Impinging on a Ground Plane, NASA CR 1307, 1969

278. Albertson, M. L., Dai, Y. B., Jensen, R. A., Reuse, H., Diffusion of Submerged Jets, Paper No. 2409, Trans. Amer. Soc. Civil Eng., Vol. 115, 1950, pp. 639-697

279. Anon., Analysis of a Jet in a Subsonic Crosswind, Symposium Proceedings, NASA SP-218, September 1969

280. Binion, T. W. Jr., Investigation of the Recirculation Region of a Flow Field Caused by a Jet in Ground Effect with Crossflow, AEDC-TR-70-192, September 1970

281. Callaghan, E. E., Ruggeri, R. S., Investigation of the Penetration of an Air Jet Directed Perpendicularly to an Air Stream, NACA TN 1615, 1948

282. Casteel, G. R., Aerodynamic Stability and Control/Wind Tunnel Data Correlation, AFFDL-TR-71-3, 1971

283. Crawford, R. A., A Combined Potential and Momentum Roll-up Model for the Jet in Cross Flow, Doctoral Dissertation, University of Tennessee, 1971

284. Delaney, N. K., Sorenson, N. F., Low Speed Drag of Cylinders of Various Shapes, NACA TN 3038, November 1953

285. Epshteyn, A. M., Shape of Turbulent Jet Axis in an Unbounded Horizontal Cross Flow, Journal of Engineering Physics, Vol. 9, No. 4, October 1965, pp. 303-306

286. Fraser, J. P., Three-Dimensional Study of a Jet Penetrating a Stream at Right Angles, Journal of Aeronautical Sciences, (Readers Forum), Vol. 21, No. 1, January 1954, pp. 59-62

287. Garner, J. R., A Review of Jet Efflux Studies Applicable to V/STOL Aircraft, AEDC-TR-67-163, September 1967

288. Gerend, R. P., Penetration of a Jet Into a Nonuniform Stream, M. S. Thesis, Seattle University, June 1968

289. Gordier, R. L., Studies on Fluid Jets Discharging Normally Into Moving Liquid, Tech. Paper No. 28, Ser. B, St. Anthony Falls Hydraulic Lab, University of Minnesota, August 1959

290. Hardy, W.G.S., Non-Parallel Flow Interactions, M.A.E. Thesis, University of Virginia, June 1967

291. Heyson, H. H., Theoretical Study of Conditions Limiting V/STOL Testing in Wind Tunnels with Solid Floor, NASA TN D-5819, June 1970

292. Heyson, H. H., Approximate Treatment of V/STOL Wall Interference for Closed Circular Tunnels, NASA TN D-6127, February 1971

293. Hill, R. W. et al, V/STOL Flight Test Instrumentation Requirements for Extraction of Aerodynamic Coefficients, AFFDL-TR-68-154, 1968

294. Kirkpatrick, D. L. I., Wind-Tunnel Corrections for V/STOL Model Testing, M.A.E. Thesis, University of Virginia, 1962

295. Lee, C. C., A Review of Research on the Interaction of a Jet with an External Stream, Tech. Note R-184, Res. Lab., Brown Engineering Co., Inc, March 1966

296. Levinsky, E. S., Strand, T., A Method for Calculating Helicopter Vortex Paths and Wake Velocities, AFFDL-TR-69-113, 1969

297. Margason, R. J., Gentry, G. L., Aerodynamic Characteristics of a Five-Jet VTOL Configuration in the Transition Speed Range, NASA TN D-4812, 1968

298. Matthews, G. B., Hardy, W.G.S., Wind Tunnel Wall Effects in V/STOL Model Testing, NASA CR-66721, 1968

299. McAllister, J. D., A Momentum Theory for the Effects of Cross Flow on Incompressible Turbulent Jets, Doctoral Dissertation, University of Tennessee, August 1968

300. McLaughlin, D. K., Laser Doppler Velocimeter Measurements in a Turbulent Jet Exiting into a Cross Flow, AEDC-TR-71-262, January 1972

301. Mosher, D. K., An Experimental Investigation of a Turbulent Jet in a Cross Flow, Doctoral Dissertation, Georgia Institute of Technology, School of Aerospace Engineering, Report No. 70-7, December 1970

302. Nayar, B. M., Siddon, T. E., Chu, W.T., Properties of the Turbulence in the Transition Region of a Round Jet, Tech. Note No. 131, Inst. Aerosp. Studies, University of Toronto, January 1969

303. Pratte, B. D., Baines, W. D., Profiles of the Round Turbulent Jet in a Cross Flow, J. Hydraulics Div., Amer. Soc. Civil Eng., Vol. 92, No. HY6, November 1967
304. Ruggeri, R. S., Callaghan, E. E., Bowden, D. T., Penetration of Air Jets Issuing from Circular, Square, and Elliptical Orifices Directed Perpendicularly to an Air Stream, NACA TN 2019, 1950
305. Seidel, M., Der Einfluss eines geneigten Strahles auf das Stroemungsfeld in der Umgebung eines Leitwerks sowie and dessen Luftkraftbeiwerk - Teil I: Versuchseinrichtung, Vorversuche und Kraftmessung mit horizontalem und vertikalem Strahl, DFL-Bericht Nr. 0487, 1968
306. Seidel, M., Der Einfluss eines geneigten Strahles auf das Stromungsfeld in der Umgebung eines Leitwerkes sowie auf dessen Luftkraftbeiwerk - Teil II: Literatur uebersicht, DFL-Bericht Nr 0532, 1969
307. Shandorov, G. S., Calculation of a Jet Axis in a Drifting Flow, NASS TT F-10, 638, 1966
308. Soukup, S. M., Potential Flow Aspects of the Cross-Sectional Deformation of Jet Configurations in Cross Flow, M. S. Thesis, University of Tennessee, December 1968
309. Spring, D. J., Street, T. A., Experimental Investigation of the Pressure Distributions Induced Upon a Body of Revolution by Several Transverse Jets at Low Speeds, Report No. RD-TM-68-7, U. S. Army Missile Command, August 1, 1968
310. Storms, K. R., Low-Speed Wind Tunnel Investigation of a Jet Directed Normal to the Wind, Report 885, Aeronaut. Lab., University of Washington, November 1965
311. Thompson, A. M., The Flow Induced by Jets Exhausting Normally from a Plane Wall into an Airstream, Doctoral Dissertation, University of London, September 1971
312. Vakhlamov, S. V., Computation of the Trajectory of a Jet in a Drifting Flow, FTD-TT-65-1977, U. S. Air Force, June 13, 1966
313. Vizel, Y. M., Mostinskii, I. L., Deflection of a Jet Injected Into a Stream, Journal of Engineering Physics, Vol. 8, No. 2, February 1965, pp. 160-163

314. Werner, J. E., Chang, H. S., Analytical Determination of the Induced Flow Due to a Jet in a Subsonic Crossflow, New York University, Department of Aeronautics and Astronautics, NYU-AA-70-21, September 1970
315. Ziegler, H., Wooler, P. T., Multiple Jets Exhausting into a Crossflow, Journal of Aircraft, Vol. 8, No. 6, June 1971, pp. 414-420